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U. S. GEOLOGICAL SURVEY
George Otis Smith, Director

# MINERAL RESOURCES

OF THE

# UNITED STATES

# 1922

G. F. LOUGHLIN
Geologist in Charge, Division of Mineral Resources

PART I—METALS

G. F. LOUGHLIN, Geologist in Charge

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# CONTENTS.

[The dates of publication of the separate chapters are given in parentheses.]


| | Page. |
|---|---|
| The mineral resources of the United States in 1922 | 1A |
| Introduction, by G. F. Loughlin | 1A |
| Summary, by M. B. Clark | 7A |
| Prefatory note to the reports on gold, silver, copper, lead, and zinc, by G. F. Loughlin | 125A |
| Cadmium, by C. E. Siebenthal and A. Stoll (May 22, 1923) | 1 |
| Gold, silver, copper, lead, and zinc in the Eastern States, by J. P. Dunlop (June 12, 1923) | 7 |
| Bismuth, by V. C. Heikes (July 16, 1923) | 15 |
| Selenium, by V. C. Heikes (July 16, 1923) | 23 |
| Tellurium, by V. C. Heikes (July 16, 1923) | 25 |
| Lead, by C. E. Siebenthal and A. Stoll (July 17, 1923) | 27 |
| Zinc, by C. E. Siebenthal and A. Stoll (July 18, 1923) | 37 |
| Arsenic, by V. C. Heikes and G. F. Loughlin (September 17, 1923) | 53 |
| Lead and zinc pigments and salts, by C. E. Siebenthal and A. Stoll (July 25, 1923) | 77 |
| Bauxite and aluminum, by J. M. Hill (August 6, 1923) | 87 |
| Antimony, by F. C. Schrader (August 7, 1923) | 97 |
| Chromite, by Edward Sampson (August 27, 1923) | 107 |
| Quicksilver, by F. L. Ransome (September 18, 1923) | 113 |
| Platinum and allied metals, by J. M. Hill (October 8, 1923) | 125 |
| Silver, copper, lead, and zinc in the Central States, by J. P. Dunlop and F. Begeman (October 10, 1923) | 137 |
| Tin, by B. L. Johnson (October 11, 1923) | 169 |
| Secondary metals, by J. P. Dunlop (November 7, 1923) | 173 |
| Gold, silver, and lead in South Dakota, by C. W. Henderson (November 20, 1923) | 193 |
| Gold, silver, and copper in Wyoming, by C. W. Henderson (November 20, 1923) | 197 |
| Gold, silver, copper, lead, and zinc in New Mexico, by C. W. Henderson (November 28, 1923) | 199 |
| Silver, copper, and lead in Texas, by C. W. Henderson (November 28, 1923) | 215 |
| Gold, silver, copper, lead, and zinc in Idaho, by C. N. Gerry (December 18, 1923) | 217 |
| Gold, silver, copper, lead, and zinc in Washington, by C. N. Gerry (December 18, 1923) | 245 |
| Copper, by H. A. C. Jenison (February 29, 1924) | 257 |
| Gold, silver, copper, lead, and zinc in Nevada, by V. C. Heikes (January 14, 1924) | 305 |
| Iron ore, pig iron, and steel, by E. F. Burchard and H. W. Davis (January 25, 1924) | 341 |
| Gold, silver, copper, lead, and zinc in Utah, by V. C. Heikes (March 8, 1924) | 377 |
| Gold, silver, copper, lead, and zinc in California, by J. M. Hill (March 10, 1924) | 405 |
| Gold, silver, copper, and lead in Oregon, by J. M. Hill (March 10, 1924) | 439 |
| Gold, silver, copper, lead, and zinc in Montana, by C. N. Gerry (March 12, 1924) | 453 |
| Gold, silver, copper, lead, and zinc in Arizona, by V. C. Heikes (March 15, 1924) | 489 |
| Gold, silver, copper, lead, and zinc in Colorado, by C. W. Henderson (March 20, 1924) | 519 |
| Cobalt, by F. L. Hess (March 14, 1924) | 557 |
| Molybdenum, by F. L. Hess (March 14, 1924) | 561 |
| Nickel, by F. L. Hess (March 14, 1924) | 563 |
| Tantalum, by F. L. Hess (March 14, 1924) | 567 |
| Titanium, by F. L. Hess (March 14, 1924) | 569 |

Page.
Tungsten, by F. L. Hess (March 14, 1924) ..... 571
Radium, uranium, and vanadium, by F. L. Hess (March 14, 1924) ..... 575
Manganese and manganiferous ores, by H. A. C. Jenison and H. M. Meyer (February 25, 1924) ..... 585
Gold and silver, by J. P. Dunlop (June 4, 1924) ..... 595
Gold, silver, copper, and lead in Alaska, by A. H. Brooks and S. R. Capps ..... 637
Index ..... 643

## ILLUSTRATIONS.

Page.
PLATE I. Curves showing production and value of gold and silver in the world, 1860–1922 ..... 600
FIGURE 1. Average weekly quoted price of lead at New York and London, 1921 and 1922 ..... 35
2. Average weekly quoted price of zinc at St. Louis and London and of 60 per cent zinc concentrates at Joplin, and weekly "production" (sales) of zinc concentrates in the Joplin region, 1921–1922 ..... 51
3. Graphs showing relation of prices of metallic zinc products to the price of prime western spelter in 1921 and 1922 at St. Louis ..... 52
4. Sales and imports of white arsenic, 1910–1922 ..... 56
5. Quoted wholesale prices of white arsenic, 1919–1922 ..... 57
6. Diagram showing relation of weekly prices of lead pigments and salts to the average weekly quoted price of lead at New York, 1921–22 ..... 82
7. Diagram showing relation of weekly prices of zinc pigments and salts to the average weekly quoted price of prime western zinc at St. Louis, 1921–22 ..... 83
8. Curves showing domestic sales, imports, supply, and prices of chromite, 1909–1922 ..... 110
9. Graphs showing the principal features of the copper industry, 1913–1922 ..... 260
10. Chart showing rank of States producing copper, 1913, 1918–1922, and 1845–1922 ..... 263
11. Curves showing annual production of iron ore, pig iron, and steel in the United States, 1870–1922 ..... 345
12. Source and district of entry of iron ore imported into the United States in 1922 ..... 357
13. Curve showing commercial quotations of basic pig iron at blast furnaces in Mahoning and Shenango valleys, Ohio and western Pennsylvania, 1916–1922, by months ..... 365
14. Curve showing daily average production of coke and anthracite pig iron in the United States, 1916–1922, by months ..... 367
15. Contract prices of ferromanganese, spiegeleisen, and manganese ore, 1918–1922 ..... 594
16. Curves showing production and value of gold and silver and price per fine ounce of silver in the United States, 1871–1922 ..... 598

# MINERAL RESOURCES OF THE UNITED STATES, 1922—PART I.

## THE MINERAL RESOURCES OF THE UNITED STATES IN 1922.[1]

### INTRODUCTION.

By G. F. Loughlin,
*Geologist in charge, Division of Mineral Resources.*

The outstanding feature of the mineral industry in the year 1922 was the recovery from the protracted slump that it had undergone in common with other industries during 1921. Improvement in some branches of the industry had begun late in 1921 and became more general and more marked during the early months of 1922, but instability was conspicuous throughout the year, owing to continued differences in degree of readjustment from a war to a peace basis. The most conspicuous evidence of instability was the greatest and longest strike in the annals of coal mining, the effects of which were intensified by the strike of the railroad shop crafts. Fortunately, stocks of coal in the hands of industrial consumers on April 1, when the coal strike began, were extraordinarily large and thus prevented any general interruption of business for some time; but after the coal strike had continued for four months and the railroad strike for one month, signs of enforced curtailment of fuel consumption appeared and difficulties in transportation began to be seriously felt. Had the strike continued much longer the mineral industry would have met with a serious setback. With the settlement of the soft-coal strike in the middle of August and the gradual improvement of transportation there was a steady improvement in the conditions that affect mineral production.

Although the year 1922 witnessed no widespread or marked changes in the cost of labor and supplies for the mining industries and no great reduction of freight rates, the general healthier tone in business, due to reduction of large stocks, particularly of metals, the increasing activity in building throughout the country, and the more favorable markets abroad enabled mineral producers in general to make a larger output than in 1921. The end of the year found the mineral industry solidly established and enjoying, if not the benefits of a normal situa-

[1] In Mineral Resources of the United States the use of leaders (------) indicates that so far as the Geological Survey has been able to ascertain there was nothing to report. If data are not available, the fact is indicated by a statement to that effect in a footnote. Leaders are also used in footings where it is quite evident that figures in a column are not addable and in other places where entries are not appropriate.

All figures of imports and exports in this report were compiled by J. A. Dorsey, of the Geological Survey, from records of the Bureau of Foreign and Domestic Commerce, Department of Commerce, having been converted by Mr. Dorsey to the various units of measurement used in this report and arranged by him in their present form. The imports are those for the calendar year unless otherwise stated. Wherever exports are shown, unless otherwise specified, the figures represent domestic products and not foreign minerals reexported, and they also cover calendar years.

tion as measured by pre-war standards, at least the assurance of ample markets and of prices better adjusted to wages and other operating costs than they had been for several years. In fact, at the time of writing (June, 1923) the fear of overproduction and of too rapid increase in prices has resulted in some curtailment.

The total value of the mineral products of the United States in 1922 was about $4,647,000,000, an increase of 12 per cent over that of 1921, but 33 per cent less than that of 1920, when prices were at the peak.

The production of soft coal rose steadily from the beginning of the year to March and declined nearly 60 per cent during the first two weeks of the strike. The shutdown was complete in all union or organized districts except western Kentucky. During April, May, and June production in the nonunion fields gradually increased, and during the two weeks just before the outbreak of the railway shopmen's strike on July 1 it exceeded 5,200,000 tons a week. Thereafter it declined and remained low until late in August, when mining was resumed in the union districts. After the strike production was maintained at a fairly high level and would doubtless have been greater during the fall if transportation disabilities had not been so general on the railroads that serve coal mines in the territory east of Mississippi River. West of the Mississippi the production was largely limited by a lack of demand, which began to be felt not long after the end of the strike. Because of these conditions the total production of bituminous coal in 1922 was only 2 per cent larger than in the dull year of 1921, when it declined to about the level of 1910 and 1911.

As a result of the strike there was a large variation in the quantity of coal in storage during the year. On January 1, 1922, consumers' stocks amounted to 48,000,000 short tons, and in anticipation of the strike there was a rapid accumulation. On March 1 there was 52,500,000 tons in stock piles, and it was estimated that by April 1 at least 63,000,000 tons were in the hands of commercial consumers. Drafts on stocks during the strike reduced the quantity in storage to 22,000,000 tons by September 1. Past experience had shown that when stocks reach the level of 20,000,000 tons a panicky market develops, with attendant high prices. However, through the efforts of the Secretary of Commerce and the office of the Federal Fuel Distributor, established September 22, 1922, the possibility of a coal panic was averted. Furthermore, the rate of production after the strike increased rapidly to the point where it was possible not only to satisfy current needs but to add to reserves, so that by the end of the year 36,000,000 tons was in storage.

The anthracite collieries began the year with steadily increasing production and attained a high rate just before the strike. From April 1 to September 9 there was a complete shut-down of anthracite mines, and the only output from the region came from dredges working in rivers and creeks. After the settlement of the strike the anthracite mines made a remarkable recovery and within one week were producing at more than the normal rate. Throughout the rest of the year production was maintained at abnormally high levels, but the 23 weeks of the strike resulted in a decrease of 40 per cent in production compared with that in 1921 and caused a deficit in the supply for household usage which could not be overcome, although the anthracite collieries continued to produce at an average of

2,000,000 tons a week throughout the first three months of 1923. Practically no anthracite went into producers' storage piles until the winter demand had ceased.

The outstanding feature of the coke industry in 1922 was the continued substitution of by-product coke for beehive coke and the remarkable fact that, despite the coal strike, the production of by-product coke increased nearly 45 per cent over that of 1921 and large accumulations of coke in stock were wiped out. After the strike was settled and improvement in transportation began the beehive-coke industry made a remarkable recovery and toward the end of the year was producing at about the rate established during the active year 1920; but the total production in 1922 was less than in any year since 1888 except 1921.

The year 1922 was marked by the establishment of a new high record in the production of petroleum. In addition to the large domestic production the imports were also large, and therefore despite unprecedented consumption and exports the accumulated stocks of petroleum, which were large at the beginning of the year, increased to the largest quantity ever accumulated. These conditions of oversupply in 1922 were reflected in the unsettled and low prices of crude oil. The increased production for the year was due chiefly to the bringing in of highly productive new fields in California, Oklahoma, Texas, Louisiana, and Arkansas, together with sustained production in most of the older producing territory in the United States. This record production exceeded that of 1921 by 18 per cent, was more than twice the output in 1914, and exceeded the production of the entire world in 1919.

The world's production of petroleum in 1922 was nearly 859,000,000 barrels, as compared with 766,000,000 barrels in 1921. The domestic production in 1922 was 557,531,000 barrels. The indicated consumption of domestic and imported crude petroleum (deliveries to consumers), amounting to 592,432,000 barrels in 1922, was 35,000,000 barrels greater than the domestic production. The difference was more than made up by imports, which amounted to 127,000,000 barrels. Imports of Mexican petroleum were maintained at record high amounts during the first half of the year but fell off considerably during the last half, in consequence of the depletion of the southern fields of Mexico.

The year 1922 opened with prices of crude petroleum at the high point of the upward reaction that began in the summer of 1921, after the drastic drop during the first half of that year, when the price of Oklahoma-Kansas grade crude oil fell from $3.50 to $1 a barrel within a few months. In January, 1922, the price of this grade was $2 a barrel, which was maintained until the middle of July, when it dropped to $1.50 a barrel, and in August the price was cut to $1.25 a barrel. In November prices of Mid-Continent crude oil were put on a gravity basis, but the $1.25 maintained for oil having a range in gravity between 33° and 34.9° Baumé remained unchanged until the end of the year.

The year closed with a distinct change in conditions that had persisted for more than two years in the petroleum industry. Beginning in November and being more pronounced in December production plus imports was less than consumption plus exports; but this deficiency was overcome in January, 1923, and during the succeeding months a surplus has been accumulating. This surplus, though far

less than that existing during the first half of 1922, is greater than at any other time since.

There was a large increase in the production of copper in 1922. Anaconda resumed operations in January, the "porphyries" late in the spring, and practically all important companies by midsummer, though at a curtailed rate, so that smelter production averaged only about 50 per cent of capacity and refinery production about 60 per cent of capacity. Among the notable events during the year were the development of a shortage of labor, the consequent necessity of increased wages, and the increased cost of materials. These conditions, however, are balanced to a large extent by the present position of the industry, which is by far the most favorable since 1918 and appears to be about normal. The striking features shown by the statistics for the year are a great reduction of stocks, large imports, small refinery production from domestic sources, comparatively small withdrawals of new copper on domestic account, and larger exports than were expected a year ago. Refinery production from domestic and foreign sources increased 33 per cent, and smelter production increased 88 per cent over that in 1921. The smelter production in 1921, however, was the smallest since 1897. Stocks of new refined copper at the end of 1922 showed a decrease of 53 per cent from those of the year before, but blister stocks showed an increase. The total new refined copper withdrawn on domestic account increased 47 per cent, largely because of the accumulated demand from 1921 and probably also because consumers, attracted by the low price, bought in advance of their needs. It is therefore probably more accurate to regard the normal requirements for 1922 as the average of deliveries in 1921 and 1922 rather than the deliveries in 1922 alone. The normal annual increment is too small to affect the result materially.

Zinc showed an increase in smelter output of 77 per cent in 1922, and the increase in consumption was even larger, so that the year ended with very small supplies of zinc on hand. Zinc mining in the Western States, which had almost lapsed in 1921, took a new lease of life under the higher prices that prevailed, especially in the later part of 1922. The importation of foreign slab zinc nearly ceased, and exports of slab and sheet zinc increased, though not to the size of the exports in the years immediately after the war.

Lead made a gain of 19 per cent in output and a gain of 11 per cent in apparent consumption. The quantity of refined lead imported in 1922 fell off greatly, and the exports increased nearly one-half over those of 1921. As a result of the revival of building, the demand for lead as well as zinc held up throughout the year, and the price of each gradually stiffened.

The production of pig iron in 1922 showed an increase of 63 per cent over that of 1921, and in response to this greater demand for ore iron mining became more active, production and shipments showing increases of 60 per cent and 90 per cent, respectively, and stocks of ore a decided reduction. The greater part of the increase in activity took place in the last half of the year. Notwithstanding this creditable showing, the quantities of iron ore, pig iron, and steel that were produced in 1922 are far below the producing capacity of the country and far below what would normally be demanded, as they rank along with the output of the years 1910 to 1914.

The increase in the production of pig iron created a large increase in the demand for manganiferous ore and low-grade manganese ore, but the production of high-grade manganese ore was only about equal to that of 1921. The larger output of steel created an increased demand for the other steel-hardening metals such as chromium, tungsten, molybdenum, vanadium, and uranium, but the general effect was an increase in the drafts on stocks and in imports of the ores of these metals rather than an increase in the domestic output. The increased production of iron and steel also called for corresponding increases in production of limestone and fluorspar for fluxes and of the different refractory materials. The demand for refractory (dead-burned) magnesite was mainly supplied from greatly increased imports; but after the passage of the new tariff act in September domestic production was resumed.

The production of gold and silver in 1922 was slightly less than had been expected. The decrease in gold, which amounted to about $1,200,000, was due principally to a smaller yield in Alaska, Colorado, and California. The low prices of lead, zinc, and copper in the early part of 1922 curtailed the production of by-product gold and silver. Owing to scarcity of labor and the tendency of operating costs to increase again many mines were not worked at capacity, and although the activity of many mines of the base ores was resumed on a considerable scale late in 1922, much of the gold and silver content of their ores had not been recovered at the refineries before the end of the year. There were decreases in the output of gold from Alaska, California, Colorado, Idaho, Montana, and Oregon, and increases in Arizona, Nevada, New Mexico, Philippine Islands, South Dakota, Utah, and Washington.

The production of silver increased about 3,188,000 ounces in 1922; the largest increases were in Arizona, Utah, and Nevada. The Pittman Act appears to have stimulated the mining of siliceous silver ores in Nevada and Utah more than in other States. The increasing output of silver late in 1922 and early in 1923, however, is largely due to the extended operations of copper and lead mines.

The price of silver that was not derived from mines in the United States and not purchasable under the Pittman Act was fairly stable in 1922, ranging from about 64 to 71 cents a fine ounce. It was lowest in the months of March and December, 1922, and it increased early in 1923. The average price was about 67.9 cents in 1922, compared with 63.1 cents in 1921. The fluctuations were normal and were mainly attributable to the demand from China and India. Domestic consumption has increased with better business conditions. As the future price of silver depends on the demand of the Orient and on the resumption of the use of silver for coinage, there are no present data on which to forecast future prices.

Among the other metals aluminum and arsenic were the most conspicuous. The total production of bauxite and the quantity of bauxite used in the production of aluminum each increased more than 100 per cent, and the smaller quantities of bauxite for chemical, abrasive, and refractory uses also increased considerably. The market for arsenic, which was very dull during 1921 and the first half of 1922, became very active during the fall and has continued active into 1923. This change was due mainly to an unexpected demand for calcium arsenate, which is being successfully used in fighting the

cotton-boll weevil. The demand grew too rapidly to be met fully by domestic production and imports combined, but as the principal demand for this and other arsenical insecticides occurs during the first half of the year it is probable that the demand for 1924 will be fully met.

The production of nearly all the nonmetallic minerals, other than anthracite, increased considerably. The only exceptions were that of asbestos, which has been regularly very small compared with imports, and those of gems and precious stones and some of the abrasives. Improvement in the chemical industries is reflected by the increase of 41 per cent in the quantity of sulphur shipped, together with increases of 8 per cent in domestic pyrites and 29 per cent in imported pyrites. Chemical lime increased 53 per cent, salt 36 per cent, aluminum salts 52 per cent, and barite 134 per cent.

Of the minerals for agricultural use phosphate rock increased 17 per cent in shipments, and potash, which had declined to comparative insignificance in 1921, increased 157 per cent. Peat doubled in quantity. The total available lime in burned lime, pulverized limestone, and calcareous marl for agricultural use decreased 6 per cent.

Improvement in the construction industries is shown by increases in shipments of cement, 23 per cent; stone of all kinds, 26 per cent; gypsum, 31 per cent; lime, 44 per cent; and slate, 48 per cent. Sales of Indiana oolitic limestone for building increased 82 per cent. Sales of stone paving blocks decreased 25 per cent, but sales of asphalt, used largely for paving, increased 23 per cent. Among materials for electrical equipment electrical slate increased 16 per cent and sheet mica increased 45 per cent.

Moderate to large increases in sales of abrasive materials, with the exception of millstones and diatomaceous earth, were also reported.

The ceramic industries in 1922 made good recovery from the slump of the year before and, as a consequence, the production of clays, feldspar, silica, and glass sand showed moderate to large increases.

# SUMMARY.

By Martha B. Clark.

## GENERAL TABLES.

*Mineral products of the United States in 1921 and 1922.*[a]

| Product. | | 1921 | | 1922 | | Percentage of increase or decrease. | |
|---|---|---|---|---|---|---|---|
| | | Quantity. | Value. | Quantity. | Value. | Quantity. | Value. |
| METALLIC. | | | | | | | |
| Aluminum | pounds | | $10,906,000 | | $13,622,000 | | +25 |
| Antimonial lead [b] | short tons (2,000 pounds) | 10,064 | 870,059 | 8,075 | 844,993 | −20 | −3 |
| Antimony [c] | do | 1,589 | [c] 158,000 | 1,441 | [c] 156,000 | −9 | −1 |
| Bauxite | long tons (2,240 pounds) | 139,550 | 889,800 | 309,600 | 2,012,330 | +122 | +126 |
| Cadmium | pounds | [d] 68,501 | [d] 67,131 | 131,590 | 143,433 | +92 | +114 |
| Chromite | long tons | 282 | 2,900 | 355 | 7,288 | +26 | +151 |
| Copper, [e] sales value | pounds | 505,586,098 | 65,221,000 | 950,285,947 | 128,289,000 | +88 | +97 |
| Ferroalloys | long tons | 248,627 | 21,697,785 | 423,280 | 28,259,004 | +70 | +30 |
| Gold [f] | troy ounces | 2,422,006 | 50,067,300 | 2,363,075 | 48,849,100 | −2 | −2 |
| Iron: | | | | | | | |
| Ore [g] | long tons | 26,652,528 | [g] 89,745,308 | 50,612,620 | [c] 157,809,286 | +90 | +76 |
| Pig | do | 16,038,619 | 389,437,792 | 27,670,738 | 608,144,858 | +73 | +56 |
| Lead (refined), [e] sales value | short tons | 398,222 | 35,840,000 | 468,746 | 51,562,000 | +18 | +44 |
| Manganese ores (35 per cent or more Mn) [h] | long tons | 13,531 | 495,097 | 15,682 | 472,501 | +16 | −5 |
| Manganiferous ore (5 to 35 per cent Mn) [h] | do | 97,099 | 255,131 | 625,659 | 1,766,419 | +544 | +592 |
| Nickel (value at New York City) | short tons | 111 | 86,000 | 208 | 133,191 | +87 | +55 |

[a] In this general statement certain of the figures represent shipments rather than quantity mined. The reader is referred to the following sections on the various mineral products for information in greater detail than it seems practicable to give here.

[b] From both domestic and foreign ores.

[c] From all sources. Values excluded from metallic totals as the values of the antimony contained in antimonial lead are included in the antimonial lead values. No antimony was produced from ores in 1921 and 1922.

[d] Revised figures.

[e] Product from domestic ores only.

[f] Value, $20.67183625323 an ounce.

[g] Value not included in total value.

[h] Including ore used for fluxing. For separation see pp. 62A–63A.

*Mineral products of the United States in 1921 and 1922*—Continued.

| Product. | | 1921 | | 1922 | | Percentage of increase or decrease. | |
|---|---|---|---|---|---|---|---|
| | | Quantity. | Value. | Quantity. | Value. | Quantity. | Value. |
| METALLIC—continued. | | | | | | | |
| Ores (crude): | | | | | | | |
| Copper | short tons | 13,396,000 | (a) | 26,893,000 | (a) | +101 | |
| Copper-lead and copper-lead-zinc | do | 14,000 | (a) | 52,000 | (a) | +271 | |
| Dry and siliceous (gold and silver) | do | [d] 8,436,000 | (a) | 8,728,000 | (a) | +3 | |
| Lead | do | 7,129,000 | (a) | 7,288,000 | (a) | +2 | |
| Lead-zinc | do | 3,736,000 | (a) | 8,555,000 | (a) | +129 | |
| Zinc | do | 1,708,000 | (a) | 2,667,000 | (a) | +56 | |
| Platinum and allied metals (value at New York City) [b] | troy ounces | 56,370 | $4,238,989 | 57,718 | $5,932,726 | +2 | +40 |
| Quicksilver (value at San Francisco) | flasks (75 pounds net) | 6,339 | 300,595 | 6,375 | 368,348 | +1 | +23 |
| Quicksilver ore | short tons | 35,000 | (a) | 43,000 | (a) | +23 | |
| Silver | troy ounces | 53,052,441 | 53,052,441 | 56,240,048 | 56,240,048 | +6 | +6 |
| Tin (metallic equivalent) | short tons | 4 | 2,400 | 1 | 912 | −75 | −62 |
| Titanium ore (rutile) | do | | | 310 | (j) | | |
| Tungsten ore (60 per cent concentrates) | do | | | | | | |
| Uranium and vanadium ores | do | 8,540 | 876,000 | 929 | 166,016 | −89 | −81 |
| Zinc, [c] sales value | do | 198,232 | 19,823,000 | 353,274 | 40,273,000 | +78 | +103 |
| Total value of metallic products (approximate) | | | 654,130,000 | | 987,180,000 | | +51 |
| NONMETALLIC. | | | | | | | |
| Arsenious oxide | short tons | 4,786 | 717,700 | 10,027 | 1,475,229 | +110 | +106 |
| Asbestos | do | 831 | 336,968 | 67 | 10,120 | −92 | −97 |
| Asphalt | do | 920,632 | 11,033,804 | 1,132,937 | 12,639,105 | +23 | +15 |
| Barytes (crude) | do | 66,369 | 531,958 | 155,040 | 1,123,950 | +134 | +111 |
| Borates | do | 50,000 | 1,600,000 | 85,220 | 2,705,140 | +70 | +69 |
| Bromine | pounds | 711,953 | 172,759 | 1,005,174 | 150,668 | +41 | −13 |
| Calcium-magnesium chloride | short tons | 23,672 | 510,723 | 33,067 | 571,326 | +40 | +12 |
| Cement | barrels (376 pounds net) | 96,046,549 | 181,675,440 | 118,590,644 | 208,464,028 | +23 | +15 |
| Clay: | | | | | | | |
| Products [k] | | | 270,397,754 | | 321,494,403 | | +19 |
| Raw [e] | short tons | [d] 1,746,746 | [d e] 6,055,300 | 2,617,700 | [e] 8,330,514 | +52 | +38 |
| Coal: | | | | | | | |
| Bituminous [l] | do | 415,921,950 | 1,199,983,600 | 422,268,099 | 1,274,820,000 | +2 | +6 |
| Pennsylvania anthracite | long tons | 80,779,867 | 452,304,903 | 48,824,127 | 273,700,125 | −40 | −39 |
| Coke [g] | short tons | 25,287,622 | [e] 147,673,095 | 37,124,012 | [e] 238,313,323 | +47 | +61 |
| Diatomaceous (infusorial) earth and tripoli | do | 67,474 | 895,629 | 74,966 | 703,397 | +11 | −21 |
| Emery | do | 305 | 2,250 | 1,468 | 17,511 | +381 | +678 |

| | | | | | | | |
|---|---|---|---|---|---|---|---|
| Feldspar (crude) | long tons | 91,865 | 617,652 | 117,127 | 844,568 | +27 | +37 |
| Fluorspar | short tons | 34,960 | 724,094 | 141,596 | 2,531,165 | +305 | +250 |
| Fuller's earth | do | 105,609 | 1,973,848 | 138,944 | 2,289,719 | +32 | +16 |
| Garnet for abrasive purposes | do | 3,048 | 260,687 | 7,054 | 566,879 | +131 | +117 |
| Gems and precious stones | | | 518,280 | | 71,106 | | − 86 |
| Graphite: | | | | | | | |
| Amorphous | short tons | 1,842 | 20,860 | 2,200 | [m] | +19 | [m] |
| Crystalline | pounds | 1,189,523 | 75,664 | 1,849,766 | 85,242 | +56 | +13 |
| Grindstones and pulpstones | short tons | 26,340 | 1,227,322 | 26,524 | 1,020,186 | +1 | −17 |
| Gypsum | do | 2,890,784 | 23,700,290 | 3,779,949 | 29,361,151 | +31 | +24 |
| Lime | do | 2,532,153 | 24,895,370 | 3,639,617 | 33,255,039 | +44 | +34 |
| Magnesite (crude) | do | 47,904 | 510,177 | 55,790 | 571,745 | +16 | +12 |
| Mica: | | | | | | | |
| Scrap | do | 2,577 | 56,849 | 6,641 | 114,045 | +158 | +101 |
| Sheet | pounds | 741,845 | 118,513 | 1,077,968 | 194,301 | +45 | +64 |
| Millstones | | | 24,524 | | 20,853 | | −15 |
| Mineral paints: | | | | | | | |
| Natural pigments [n] | short tons | [n] | [n] | [n] | [n] | [n] | [n] |
| Zinc and lead pigments [o] | do | 102,463 | 14,801,032 | 162,815 | 22,205,400 | +59 | +50 |
| Mineral waters | gallons sold | 34,781,238 | 4,876,445 | 38,492,881 | 5,498,269 | +11 | +13 |
| Natural gas | M cubic feet | 662,052,000 | 174,617,000 | 762,546,000 | 221,535,000 | +15 | +27 |
| Natural-gas gasoline | gallons | 449,934,402 | 61,815,258 | 505,832,000 | 72,711,063 | +12 | +18 |
| Oilstones, etc | short tons | 831 | 173,025 | 1,016 | 197,450 | +22 | +14 |
| Peat | do | 30,406 | 260,119 | 60,680 | 397,729 | +100 | +53 |
| Petroleum | barrels (42 gallons) | 472,183,000 | 814,745,000 | 557,531,000 | 895,111,000 | +18 | +10 |
| Phosphate rock | long tons | 2,064,025 | 12,270,070 | 2,417,883 | 10,482,846 | +17 | −15 |
| Potash ($K_2O$) | short tons | 4,408 | 447,859 | 11,313 | 463,512 | +157 | +3 |
| Pumice | do | 37,108 | 158,540 | 45,262 | 175,600 | +22 | +11 |
| Pyrites | long tons | 157,118 | 711,432 | 169,043 | 671,241 | +8 | −6 |
| Salt | short tons | 4,981,154 | 24,557,966 | 6,792,849 | 27,464,838 | +36 | +12 |
| Sand: | | | | | | | |
| Glass | do | 1,280,359 | 2,314,314 | 1,768,549 | 2,866,366 | +38 | +24 |
| Molding, building, etc., and gravel | do | 78,564,649 | [d] 54,169,931 | 93,098,497 | 61,751,298 | +18 | +14 |
| Sand-lime brick [k] | thousands | 93,105 | 1,216,077 | [p] | [p] | | |
| Silica (quartz) | short tons | 11,252 | 84,957 | 10,653 | 101,347 | −5 | +19 |
| Slate | do | 411,500 | 7,322,006 | 607,680 | 9,176,784 | +48 | +25 |
| Stone | do | 63,538,740 | 106,962,266 | 80,211,560 | 122,066,928 | +26 | +14 |
| Sulphur | long tons | 954,344 | 17,000,000 | 1,343,624 | 22,000,000 | +41 | +29 |

[b] From both foreign and domestic ores.
[d] Revised figures.
[e] Product from domestic ores only.
[o] Value not included in total value.
[i] Figures showing values not available.
[j] Value included in total value of metallic products. Survey not at liberty to publish figures.
[k] Canvass discontinued by Geological Survey after 1920. Figures obtained through cooperation with Bureau of Census
[l] Includes brown coal and lignite, and anthracite mined elsewhere than in Pennsylvania.
[m] Value included in total value of nonmetallic products. Survey not at liberty to publish figures.
[n] Canvass discontinued after 1915. Value of iron ore sold for paint included under last item ("Unspecified").
[o] Sublimed blue lead, sublimed white lead, leaded zinc oxide, and zinc oxide.
[p] No canvass for 1922. Estimate of value included in total value of nonmetallic products.

*Mineral products of the United States in 1921 and 1922*—Continued.

| Product. | 1921 | | 1922 | | | |
|---|---|---|---|---|---|---|
| | Quantity. | Value. | Quantity. | Value. | Percentage of increase or decrease. | |
| | | | | | Quantity. | Value. |
| NONMETALLIC—continued. | | | | | | |
| Sulphur acid (60° Baumé) from copper and zinc smelters.....short tons | [q] 621,026 | [q] $6,576,500 | (p) | (p) | | |
| Talc and soapstone.....do | [d] 121,986 | [d] 1,755,942 | 198,684 | $2,859,897 | +63 | +63 |
| Total value of nonmetallic products (approximate) | | 3,481,720,000 | | 3,656,410,000 | | +5 |
| SUMMARY. | | | | | | |
| Total value of metallic products | | 654,130,000 | | 987,180,000 | | +51 |
| Total value of nonmetallic products (exclusive of mineral fuels) | | 778,250,000 | | 918,530,000 | | +18 |
| Total value of mineral fuels | | 2,703,470,000 | | 2,737,880,000 | | +1 |
| Total value of "unspecified" (metallic and nonmetallic) products (partly estimated) [r] | | 2,650,000 | | [r] 3,700,000 | | +40 |
| Grand total approximate value of all mineral products | | 4,138,500,000 | | 4,647,290,000 | | +12 |

[d] Revised figures.

[p] No canvass for 1922. Estimate of value included in total value of nonmetallic products.

[q] Canvass discontinued by Geological Survey after 1920. Figures for 1921 obtained through cooperation with Bureau of Census and represent production, the value having been partly estimated by the Survey to cover acid consumed by producer as well as that sold.

[r] Includes in 1922 the value of the following products: Bismuth, cadmium sulphide ($152,295), chats ($175,000), chert ($20,209), cobalt ($1,419), columbite ($240), flint lining for tube mills, ilmenite, iron ore sold for paint ($166,682), lithium minerals ($41,300), marls ($259,996), mineral black, pebbles for grinding, selenium ($177,542), silica sand and sandstone, finely ground ($1,061,057), sodium salts (sodium carbonate, sodium bicarbonate, sodium sulphate, and trona) from natural sources ($726,176), tellurium, zircon ($1,150), and an estimate of the value of miscellaneous mineral products, statistics for which are not collected annually by the Survey.

*Total value of mineral products of the United States from 1880 to 1922.*

| Year. | Metallic. | | Nonmetallic. | | Unspecified (metallic and nonmetallic). | Total. | |
|---|---|---|---|---|---|---|---|
| | Value. | Percentage of increase or decrease. | Value. | Percentage of increase or decrease. | | Value. | Percentage of increase or decrease. |
| 1880–1911 [a] | $12,851,263,000 | | $17,718,176,000 | | $55,122,000 | $30,624,561,000 | |
| 1912 | 862,008,000 | +27 | 1,375,420,000 | +11 | 366,000 | 2,237,794,000 | +16 |
| 1913 | 878,869,000 | +2 | 1,554,298,000 | +13 | 378,000 | 2,433,545,000 | +9 |
| 1914 | 686,639,000 | −22 | 1,424,063,000 | −8 | 470,000 | 2,111,172,000 | −13 |
| 1915 | 991,730,000 | +44 | 1,400,484,000 | −2 | 2,430,000 | 2,394,644,000 | +13 |
| 1916 | 1,620,745,000 | +63 | 1,884,413,000 | +35 | 3,281,000 | 3,508,439,000 | +47 |
| 1917 | 2,086,234,000 | +29 | 2,900,462,000 | +54 | 5,800,000 | 4,992,496,000 | +42 |
| 1918 | 2,153,318,000 | +3 | 3,380,690,000 | +17 | 6,700,000 | 5,540,708,000 | +11 |
| 1919 | 1,359,744,000 | −37 | 3,232,626,000 | −4 | 3,400,000 | 4,595,770,000 | −17 |
| 1920 | 1,762,350,000 | +30 | 5,214,170,000 | +61 | 4,820,000 | 6,981,340,000 | +52 |
| 1921 | 654,130,000 | −63 | 3,481,720,000 | −33 | 2,650,000 | 4,138,500,000 | −41 |
| 1922 | 987,180,000 | +51 | 3,656,410,000 | +5 | 3,700,000 | 4,647,290,000 | +12 |
| Grand total | 26,894,210,000 | | 47,222,932,000 | | 89,117,000 | 74,206,259,000 | |

[a] For totals by years prior to 1912 see Mineral Resources, 1920.

| Rank in value. | Product | Principal producing States.[a] | |
|---|---|---|---|
| | | In order of quantity. | In order of value. |
| 23 | Aluminum | | New York, North Carolina, Tennessee. |
| 42 | Antimonial lead | Not separable by States | Not separable by States. |
| 37 | Arsenious oxide | do | Do. |
| 77 | Asbestos | California, Vermont, Arizona, Maryland | Maryland, Arizona, California, Vermont. |
| 24 | Asphalt | Texas, California, Illinois, Indiana | California, Texas, Illinois, Indiana. |
| 39 | Barytes (crude) | Missouri, Georgia, Tennessee, Alabama | Georgia, Missouri, Tennessee, Alabama. |
| 35 | Bauxite | Arkansas, Georgia, Alabama, Tennessee | Rank same as for quantity. |
| 46 | Bismuth | Not separable by States | Not separable by States. |
| 32 | Borates | California, Nevada | Rank same as for quantity. |
| 30 | Briquets, fuel | Wisconsin, Pennsylvania, Washington, Oregon | Wisconsin, Oregon, Pennsylvania, Washington. |
| 63 | Bromine | Michigan, West Virginia, Ohio | Rank same as for quantity. |
| 55 | Cadmium (metal and sulphide) | Not separable by States | Not separable by States. |
| 48 | Calcium-magnesium chloride | Michigan, West Virginia, Ohio | Rank same as for quantity. |
| 7 | Cement | Pennsylvania, Indiana, California, Illinois | Pennsylvania, California, Indiana, Michigan. |
| 61 | Chats | Missouri | Rank same as for quantity. |
| 73 | Chert | Alabama | Do. |
| 78 | Chromite | California, Maryland, Oregon | Do. |
| 4 | Clay products | | Ohio, Pennsylvania, New Jersey, Illinois. |
| 27 | Clay, raw | Missouri, Pennsylvania, New Jersey, Ohio | Pennsylvania, Missouri, New Jersey, Georgia. |
| 1 | Coal: | | |
| | Bituminous | Pennsylvania, West Virginia, Illinois, Kentucky | Rank same as for quantity. |
| | Pennsylvania anthracite | Pennsylvania | Do. |
| 80 | Cobalt | Nevada | Do. |
| 5 | Coke | Pennsylvania, Ohio, Indiana, Alabama | Pennsylvania, Ohio, Indiana, Illinois. |
| 9 | Copper | Arizona, Montana, Michigan, Utah | Rank same as for quantity. |
| 44 | Diatomaceous earth and tripoli | California, Illinois, Oklahoma, Oregon | Do. |
| 74 | Emery | Virginia, New York | Do. |
| 43 | Feldspar (crude) | North Carolina, Maine, New Hampshire, New York | Do. |
| 19 | Ferroalloys | Pennsylvania, New York, Ohio, Tennessee | Do. |
| 76 | Flint lining for tube mills | Minnesota | Do. |
| 33 | Fluorspar | Illinois, Kentucky, Colorado, New Mexico | Illinois, Kentucky, New Mexico, Colorado. |
| 34 | Fuller's earth | Florida, Georgia, Texas, Illinois | Rank same as for quantity. |
| 49 | Garnet, abrasive | New York, New Hampshire | Do. |
| 69 | Gems and precious stones | | Montana, Arizona, California, Nevada. |
| 15 | Gold | California, Alaska, South Dakota, Colorado | Rank same as for quantity. |
| 65 | Graphite | | Texas, Alabama, Rhode Island, California. |
| | Amorphous | Rhode Island, Nevada | Rank same as for quantity. |
| | Crystalline | Texas, Alabama, California | Do. |
| 41 | Grindstones and pulpstones | Ohio, West Virginia, Michigan | Do |
| 18 | Gypsum | New York, Iowa, Michigan, Ohio | New York, Iowa, Ohio, Michigan. |
| | Iron: | | |
| 8 | Ore | Minnesota, Michigan, Alabama, Wisconsin | Rank same as for quantity. |
| 3 | Pig | Pennsylvania, Ohio, Illinois, Alabama | Pennsylvania, Ohio, Illinois, Indiana. |

| | | | |
|---|---|---|---|
| 14 | Lead | Missouri, Idaho, Utah, Oklahoma | Rank same as for quantity. |
| 17 | Lime | Ohio, Pennsylvania, West Virginia, Missouri | Ohio, Pennsylvania, Massachusetts, Missouri. |
| 71 | Lithium minerals | South Dakota, California, New Mexico | Rank same as for quantity. |
| 47 | Magnesite (crude) | California, Washington | Do |
| 50 | Manganese ore | Montana, Arkansas, Virginia, California | Do. |
| 36 | Manganiferous ore | Minnesota, New Mexico, Colorado, Michigan | Do. |
| 56 | Manganiferous zinc residuum | New Jersey | Do. |
| | Marl: | | |
| 57 | Calcareous | Virginia, California, West Virginia, Arkansas | California, Virginia, West Virginia, Arkansas. |
| 70 | Greensand | New Jersey | Rank same as for quantity. |
| 54 | Mica | North Carolina, Alabama, South Dakota, New Hampshire | North Carolina, New Hampshire, Virginia, New Mexico. |
| | Scrap | North Carolina, Alabama, South Dakota, New Mexico | North Carolina, New Mexico, South Dakota, Virginia. |
| | Sheet | North Carolina, New Hampshire, Virginia, Georgia | Rank same as for quantity. |
| 72 | Millstones | | New York, North Carolina, Virginia, Alabama. |
| 21 | Mineral paints, zinc and lead pigments | Pennsylvania, Missouri, Ohio, Kansas | Pennsylvania, Missouri, Ohio, Illinois. |
| 29 | Mineral waters | New York, Wisconsin, California, Minnesota | Wisconsin, New York, California, Maine. |
| 6 | Natural gas | West Virginia, Oklahoma, Pennsylvania, California | West Virginia, Pennsylvania, Oklahoma, Ohio. |
| 11 | Natural-gas gasoline | Oklahoma, Texas, California, West Virginia | Rank same as for quantity. |
| 64 | Nickel | Not separable by States | Not separable by States. |
| 58 | Oilstones, etc | Indiana, Ohio, New Hamsphire, Arkansas | Arkansas, Indiana, Ohio, Vermont. |
| 52 | Peat | New Jersey, California, Illinois, Michigan | Rank same as for quantity. |
| 75 | Pebbles for grinding | California, Minnesota | Do. |
| 2 | Petroleum | Oklahoma, California, Texas, Louisiana | Oklahoma, Texas, California, Kansas. |
| 25 | Phosphate rock | Florida, Tennessee, Kentucky, Idaho | Rank same as for quantity. |
| 28 | Platinum and allied metals | California, Oregon, Alaska, Idaho | Do. |
| 51 | Potash ($K_2O$) | California, Utah, Colorado, Nebraska | Do. |
| 60 | Pumice | Kansas, Nebraska, Arizona | Do. |
| 45 | Pyrites | California, Virginia, New York, Wisconsin | Do. |
| 53 | Quicksilver | California, Texas, Nevada, Oregon | Do. |
| 20 | Salt | Michigan, New York, Ohio, Kansas | Michigan, New York, Kansas, Ohio. |
| 12 | Sand and gravel | Illinois, New York, Pennsylvania, Ohio | Pennsylvania, Ohio, Illinois, New York. |
| 59 | Selenium | Not separable by States | Not separable by States. |
| 67 | Silica (quartz) | Wisconsin, Connecticut, Maryland, New York | Rank same as for quantity. |
| 40 | Silica sand and sandstone (finely ground) | Illinois, New Jersey, Pennsylvania, West Virginia | Illinois, Pennsylvania, West Virginia, New Jersey. |
| 13 | Silver | Utah, Montana, Nevada, Idaho | Rank same as for quantity. |
| 26 | Slate | | Pennsylvania, Vermont, New York, Maine. |
| 38 | Sodium salts (other than NaCl) from natural sources. | California, Wyoming, Utah | Rank same as for quantity. |
| 10 | Stone | Pennsylvania, Ohio, Michigan, Illinois | Pennsylvania, Indiana, Ohio, New York. |
| 22 | Sulphur | Texas, Louisiana, Nevada, Utah | Rank same as for quantity. |
| 31 | Talc and soapstone | Vermont, New York, Virginia, California | New York, Virginia, Vermont, California. |
| 79 | Tellurium | Not separable by States | Not separable by States. |
| 82 | Tin | Alaska | Rank same as for quantity. |
| | Titanium ore: | | |
| 66 | Ilmenite | Florida, Virginia | Do. |
| 68 | Rutile | Virginia | Do. |
| 62 | Uranium and vanadium ores | Colorado, Utah | Utah, Colorado. |
| 16 | Zinc | Oklahoma, New Jersey, Montana, Kansas | Rank same as for quantity. |
| 81 | Zircon | Florida | Do. |
| 82 | Columbite | South Dakota | Do. |

[a] Rank of States in metal production (except aluminum, ferroalloys, and pig iron) arranged according to mines reports, not smelter output.

10253°—25†—2

*States and their principal mineral products in 1922.*[a]

| State. | Rank. | Percentage of total value for United States. | Principal mineral products in order of value. |
|---|---|---|---|
| Alabama | 18 | 1.49 | Coal, iron ore, cement, clay products. |
| Alaska | 28 | .47 | Copper, gold, silver, coal. |
| Arizona | 15 | 1.54 | Copper, silver, gold, lead. |
| Arkansas | 26 | .76 | Petroleum, coal, natural gas, bauxite. |
| California | 4 | 6.85 | Petroleum, cement, natural gas, clay products. |
| Colorado | 22 | 1.32 | Coal, gold, silver, clay products. |
| Connecticut | 42 | .13 | Clay products, stone, lime, sand and gravel. |
| Delaware | 50 | .01 | Clay products, stone, sand and gravel. |
| District of Columbia | 48 | .02 | Sand and gravel, clay products, stone. |
| Florida | 36 | .26 | Phosphate rock, fuller's earth, stone, clay products. |
| Georgia | 34 | .27 | Clay products, stone, fuller's earth, cement. |
| Idaho | 29 | .45 | Lead, silver, gold, copper. |
| Illinois | 6 | 5.92 | Coal, clay products, petroleum, cement. |
| Indiana | 10 | 2.62 | Coal, cement, clay products, stone. |
| Iowa | 24 | .88 | Coal, cement, clay products, gypsum. |
| Kansas | 11 | 2.51 | Petroleum, coal, natural gas, cement. |
| Kentucky | 8 | 3.84 | Coal, petroleum, clay products, natural gas. |
| Louisiana | 13 | 1.83 | Petroleum, sulphur, natural gas, natural-gas gasoline |
| Maine | 40 | .13 | Stone, lime, clay products, slate. |
| Maryland | 32 | .36 | Coal, clay products, cement, sand and gravel. |
| Massachusetts | 35 | .27 | Stone, lime, clay products, sand and gravel. |
| Michigan | 12 | 2.45 | Iron ore, copper, cement, salt. |
| Minnesota | 9 | 2.70 | Iron ore, stone, cement, clay products. |
| Mississippi | 47 | .04 | Sand and gravel, clay products, mineral waters, stone. |
| Missouri | 16 | 1.51 | Lead, clay products, coal, cement. |
| Montana | 20 | 1.44 | Copper, silver, coal, zinc. |
| Nebraska | 44 | .07 | Cement, clay products, sand and gravel, stone. |
| Nevada | 30 | .44 | Silver, gold, copper, gypsum. |
| New Hampshire | 46 | .05 | Stone, clay products, sand and gravel, feldspar |
| New Jersey | 17 | 1.51 | Clay products, zinc, cement, sand and gravel. |
| New Mexico | 31 | .44 | Coal, copper, silver, gold. |
| New York | 14 | 1.78 | Clay products, cement, gypsum, stone. |
| North Carolina | 39 | .18 | Clay products, stone, sand and gravel, coal. |
| North Dakota | 43 | .09 | Coal, clay products, mineral waters, sand and gravel. |
| Ohio | 7 | 5.73 | Coal, clay products, natural gas, petroleum. |
| Oklahoma | 2 | 8.92 | Petroleum, natural gas, natural-gas gasoline, zinc. |
| Oregon | 41 | .13 | Cement, sand and gravel, stone, clay products. |
| Pennsylvania | 1 | 19.91 | Coal, cement, clay products, natural gas. |
| Rhode Island | 49 | .02 | Stone, clay products, lime, mineral waters. |
| South Carolina | 45 | .06 | Stone, clay products, sand and gravel, mineral waters. |
| South Dakota | 38 | .18 | Gold, stone, sand and gravel, silver. |
| Tennessee | 25 | .85 | Coal, clay products, cement, stone. |
| Texas | 5 | 6.04 | Petroleum, sulphur, natural-gas gasoline, natural gas. |
| Utah | 19 | 1.47 | Silver, coal, copper, lead. |
| Vermont | 37 | .23 | Stone, slate, talc, lime. |
| Virginia | 23 | .93 | Coal, clay products, stone, cement. |
| Washington | 27 | .48 | Coal, cement, clay products, stone. |
| West Virginia | 3 | 8.68 | Coal, natural gas, petroleum, clay products. |
| Wisconsin | 33 | .33 | Stone, iron ore, mineral waters, sand and gravel. |
| Wyoming | 21 | 1.41 | Petroleum, coal, natural gas, natural-gas gasoline. |

[a] In this table iron ore, not pig iron, is taken as the basis of iron valuation, and in the case of other metals mine production (recoverable content of metals) is the basis.

*Prices of silver, copper, lead, and zinc, 1913–1922.*

| Year. | Silver.[a] | Copper.[b] | Lead.[c] | Zinc.[d] | Year. | Silver.[a] | Copper.[b] | Lead.[c] | Zinc.[d] |
|---|---|---|---|---|---|---|---|---|---|
| | *Per fine ounce.* | *Per pound.* | *Per pound.* | *Per pound.* | | *Per fine ounce.* | *Per pound.* | *Per pound.* | *Per pound.* |
| 1913 | $0.604 | $0.155 | $0.044 | $0.056 | 1918 | $0.98 | $0.247 | $0.071 | $0.091 |
| 1914 | .553 | .133 | .039 | .051 | 1919 | 1.12 | .186 | .053 | .073 |
| 1915 | .507 | .175 | .047 | .124 | 1920 | 1.09 | .184 | .080 | .081 |
| 1916 | .658 | .246 | .069 | .134 | 1921 | 1.00 | .129 | .045 | .050 |
| 1917 | .824 | .273 | .086 | .102 | 1922 | 1.00 | .135 | .055 | .057 |

[a] Average price furnished by Bureau of the Mint.
[b] For 1913–1915, U. S. Geological Survey computation for electrolytic copper based on quotations by technical journals. For 1916 and later years, average price, all marketable grades.
[c] For 1913–1915, New York price, U. S. Geological Survey computation from daily market spot quotations. For 1916, from outside spot quotations at New York. For 1917 and later years, average price.
[d] For 1913–1914, St. Louis price, U. S. Geological Survey computation from daily market spot quotations. For 1915 and later years, average price, all grades.

# DETAILED TABLES.

## ABRASIVE MATERIALS.

### PRODUCTION.

*Natural abrasives sold by producers in the United States, 1920–1922.*

| Abrasive. | 1920 | | 1921 | | 1922 | |
|---|---|---|---|---|---|---|
| | Short tons. | Value. | Short tons. | Value. | Short tons. | Value. |
| Millstones | (a) | $63,325 | (a) | $24,524 | (a) | $20,853 |
| Grindstones and pulpstones | 53,484 | 1,707,004 | 26,310 | 1,227,322 | 26,524 | 1,020,186 |
| Oilstones and scythestones | 1,144 | 231,747 | 831 | 173,025 | 1,016 | 197,450 |
| Emery | 2,327 | 21,685 | 305 | 2,250 | 1,468 | 17,511 |
| Garnet | 5,476 | 434,425 | 3,048 | 260,687 | 7,054 | 566,879 |
| Abrasive quartz and feldspar | (b) | (b) | (b) | (b) | (b) | (b) |
| Diatomaceous (infusorial) earth and tripoli [c] | 102,155 | 1,649,370 | 67,474 | 895,629 | 74,966 | 703,397 |
| Pumice | 41,838 | 114,433 | 37,108 | 158,540 | 45,262 | 175,600 |
| Grinding pebbles | 10,924 | 77,823 | 989 | 14,637 | 3,159 | 30,798 |
| Tube-mill lining | | | | | | |
| | | 4,299,812 | | 2,756,614 | | 2,732,674 |

[a] Figures not available, as product is not reported by weight.
[b] See sections on feldspar and silica.
[c] Includes rottenstone and for 1921 an estimate for part of the diatomaceous earth.

### IMPORTS AND EXPORTS.

*Value of abrasive materials imported for consumption in the United States, 1918–1922.*

| Material. | 1918 | 1919 | 1920 | 1921 | 1922 |
|---|---|---|---|---|---|
| Millstones and burrstones | $20,017 | $26,356 | $20,954 | $13,556 | $15,356 |
| Grindstones and pulpstones | 27,361 | 50,551 | 77,046 | 81,880 | 81,733 |
| Hones, oilstones, and whetstones | 6,075 | 12,199 | 56,416 | 35,761 | 48,938 |
| Emery and corundum | 614,167 | 595,203 | 617,187 | 393,454 | 389,390 |
| Diatomaceous earth, tripoli, and rottenstone | 11,128 | 12,545 | 16,323 | 13,203 | 10,429 |
| Pumice | 33,014 | 119,781 | 249,995 | 173,201 | 118,458 |
| Diamond dust and bort | 475,870 | 1,420,442 | 3,387,488 | 466,345 | 1,029,261 |
| Garnet | (a) | (a) | (a) | (a) | [a] 1,837 |
| | 1,187,632 | 2,237,077 | 4,425,409 | 1,177,400 | 1,695,402 |

[a] Not separately classified prior to Sept. 22, 1922.

*Value of domestic abrasive materials exported from the United States, 1918–1922.*

| Material. | 1918 | 1919 | 1920 | 1921 | 1922 |
|---|---|---|---|---|---|
| Grindstones | $210,889 | $297,068 | $424,322 | $281,976 | $281,413 |
| Abrasive wheels, emery, and other | 3,862,531 | 3,032,067 | 2,791,128 | 1,318,804 | 644,151 |
| All other | 1,982,822 | 2,809,231 | 3,810,171 | 1,719,810 | 292,051 |
| | 6,056,242 | 6,138,366 | 7,025,621 | 3,320,590 | 1,217,615 |

## ALUMINUM.

[See Bauxite and aluminum.]

## ANTIMONY AND ANTIMONIAL LEAD.

### PRODUCTION.

*Mine production of antimony ores in the United States, 1915–1922, in short tons.*[a]

| Year. | Quantity. | Antimony content. |
|---|---|---|
| 1915 | 5,000 | 2,100 |
| 1916 | 4,500 | 1,770 |
| 1917 | 1,060 | 390 |
| 1918 | 190 | 50 |
| 1922 | 20 | 4 |

[a] Mine production negligible prior to 1915, and no production from 1919 to 1921, inclusive.

*Smelter production of metallic antimony in the United States, 1917–1918.*[a]

| Year. | From domestic ores. | | From foreign ores. | | Total. | |
|---|---|---|---|---|---|---|
| | Short tons. | Value. | Short tons. | Value. | Short tons. | Value. |
| 1917 | 258 | $106,812 | 2,182 | $903,348 | 2,440 | $1,010,160 |
| 1918 | 127 | 32,004 | 2,490 | 627,480 | 2,617 | 659,484 |

[a] Not recorded prior to 1917.

Only two smelters reported production (all from foreign ores) in 1919 and one in 1920, and the Survey is not at liberty to publish the figures. There was no production in 1921 and 1922.

*Secondary antimony and antimony content of secondary alloys recovered from old alloys, scrap, and dross in the United States, 1917–1922.*

| Year. | Short tons. | Value.[a] | Year. | Short tons. | Value.[a] |
|---|---|---|---|---|---|
| 1917 | 4,961 | $2,061,700 | 1920 | 5,600 | $938,560 |
| 1918 | 5,226 | 1,317,000 | 1921 | 4,720 | 464,400 |
| 1919 | 4,399 | 717,900 | 1922 | 7,090 | 765,700 |

[a] Values calculated at average yearly price for ordinary brands of antimony as published by the American Metal Market.

*By-product antimonial lead produced in the United States from both foreign and domestic ores, 1917–1922.*

| Year. | Short tons. | Value. | Antimony content (short tons). | Year. | Short tons. | Value. | Antimony content (short tons). |
|---|---|---|---|---|---|---|---|
| 1917 | 18,646 | $3,781,560 | 2,759 | 1920 | 12,535 | $1,963,255 | 2,033 |
| 1918 | 18,570 | 2,826,350 | 2,566 | 1921 | 10,064 | 870,059 | 1,589 |
| 1919 | 13,874 | 1,513,968 | 1,943 | 1922 | 8,075 | 844,993 | 1,441 |

## IMPORTS AND EXPORTS.

*Antimony imported for consumption in the United States, 1918–1922.*

| Year. | Antimony ore.[a] | | | Liquated antimony sulphide.[b] | | Metallic antimony.[c] | | Antimony oxide and other compounds.[d] | |
|---|---|---|---|---|---|---|---|---|---|
| | Short tons. | Antimony content. | | Short tons. | Value. | Short tons. | Value. | Short tons. | Value. |
| | | Short tons. | Value. | | | | | | |
| 1918 | 3,363 | 1,425 | $177,731 | 833 | $113,258 | 14,011 | $3,065,619 | 18 | $11,904 |
| 1919 | 993 | 409 | 54,477 | 273 | 19,202 | 7,159 | 1,021,587 | 126 | 9,501 |
| 1920 | 1,709 | 682 | 70,285 | 1,375 | 123,902 | 9,817 | 1,216,376 | 298 | 25,260 |
| 1921 | 213 | 98 | 11,682 | 353 | 17,577 | 10,130 | 784,146 | 154 | 15,558 |
| 1922 | | | | 689 | 40,108 | 9,344 | 659,242 | 379 | 65,538 |

[a] Classified in tariff classification as "Antimony ore and stibnite containing antimony."
[b] Classified in tariff classification as "Antimony matte, containing not more than 10 per cent of lead"; also as "Needle or liquated antimony."
[c] Classified in tariff classification as "Antimony regulus or metal."
[d] Classified in tariff classification as "Antimony, oxide, salts, and compounds of."

*Foreign antimony exported from the United States, 1918–1922.*[a]

| Year. | Ore. | | | Matte, regulus, or metal. | |
|---|---|---|---|---|---|
| | Short tons. | Antimony content (pounds). | Value. | Pounds. | Value. |
| 1918 | | | | 1,410,970 | $164,666 |
| 1919 | 3 | 5,380 | $1,665 | 429,059 | 33,913 |
| 1920 | | | | 896,034 | 51,607 |
| 1921 | | | | 299,776 | 15,741 |
| 1922 | | | | 37,218 | 1,548 |

[a] During 1922 domestic exports of "matte, regulus, or metal" were 224,610 pounds, valued at $13,961. This is the first export of domestic antimony of which there is any record. However, foreign antimony manufactured in the United States and exported would be classed as domestic exports.

## PRICES.

The average New York prices for the ordinary grades of metallic antimony are given by the American Metal Market as follows:

*Average price (cents per pound) of metallic antimony at New York, 1917–1922, by years.*

| | | | |
|---|---|---|---|
| 1917 | 20.73 | 1920 | 8.38 |
| 1918 | 12.55 | 1921 | 4.92 |
| 1919 | 8.16 | 1922 | 5.42 |

## ARSENIC.

## PRODUCTION.

*White arsenic (refined and crude), produced in the United States, sold in 1917–1922.*

| Year. | Short tons. | Value. | Year. | Short tons. | Value. |
|---|---|---|---|---|---|
| 1917 | 6,151 | $1,118,313 | 1920 | 11,502 | $2,021,356 |
| 1918 | [a] 6,323 | 1,213,000 | 1921 | 4,786 | 717,700 |
| 1919 | [a] 6,029 | 1,181,684 | 1922 | 10,027 | 1,475,229 |

[a] In addition to the arsenious oxide (or white arsenic) metallic arsenic was produced from ore in 1918 and 1919. The totals shown include this metallic arsenic.

## IMPORTS AND EXPORTS.

*Arsenic compounds imported for consumption in the United States, 1918–1922.*[a]

| Year. | Arsenic or arsenious acid (white arsenic, $As_2O_3$). | | Arsenic and sulphide of, or orpiment. | | Sheep dip. | | Paris green and London purple. | |
|---|---|---|---|---|---|---|---|---|
| | Short tons. | Value. | Short tons. | Value. | Pounds. | Value. | Pounds. | Value. |
| 1918 | 1,847 | $441,212 | 4,842 | $840,600 | (b) | $23,538 | | |
| 1919 | 4,389 | 624,494 | 2,151 | 316,687 | 146,803 | 12,346 | 18 | $14 |
| 1920 | 3,740 | 532,635 | 4,080 | 684,016 | 70,168 | 5,150 | 772 | 277 |
| 1921 | 1,669 | 253,250 | 3,343 | 531,322 | 61,377 | 6,362 | 325 | 123 |
| 1922 | 1,081 | 162,494 | 3,815 | 472,044 | 70,390 | 4,877 | 3,866 | 741 |

[a] Also 41,296 pounds of "acid," valued at $4,195, and 22,487 pounds of "metallic arsenic," valued at $3,484, imported Sept. 22 to Dec. 31, 1922. Not separately classified prior to new tariff.
[b] Figures not available.

*Foreign arsenic and sulphide of, or orpiment, exported from the United States, 1917–1922.*[a]

| Year. | Pounds. | Value. | Year. | Pounds. | Value. |
|---|---|---|---|---|---|
| 1917 | 113,600 | $15,840 | 1920 | 13,799 | $1,827 |
| 1918 | 80,050 | 12,017 | 1921 | 23,765 | 2,835 |
| 1919 | | | 1922 | 14,290 | 1,555 |

[a] There are no domestic exports.

# ASBESTOS.

## SUPPLY.

*Supplies of asbestos in the United States, 1918–1922.*

| Year. | Domestic shipments. | | Imports (unmanufactured).[a] | | Exports (unmanufactured). | | Apparent available supply.[b] | |
|---|---|---|---|---|---|---|---|---|
| | Short tons. | Value. | Short tons. | Value. | Short tons. | Value. | Short tons. | Value. |
| 1918 | 998 | $118,687 | 137,700 | $6,337,608 | 697 | $51,053 | 138,001 | $6,405,242 |
| 1919 | 1,161 | 248,265 | 135,270 | 7,369,685 | 1,119 | 157,416 | 135,312 | 7,460,534 |
| 1920 | 1,648 | 678,231 | 167,558 | 9,120,253 | 615 | 141,071 | 168,591 | 9,657,413 |
| 1921 | 831 | 336,968 | 72,463 | 2,948,302 | 520 | 101,600 | 72,774 | 3,183,670 |
| 1922 | 67 | 10,120 | 149,427 | 5,144,700 | 376 | 49,939 | 149,118 | 5,104,881 |

[a] Imports for consumption and mainly from Canada.
[b] Production plus imports minus exports.

## PRODUCTION.

*Domestic asbestos sold in the United States, 1918–1922, by varieties.*

| Year. | Chrysotile. | | Amphibole. | | Total. | |
|---|---|---|---|---|---|---|
| | Short tons. | Value. | Short tons. | Value. | Short tons. | Value. |
| 1918 | 392 | $101,059 | 606 | $17,628 | 998 | $118,687 |
| 1919 | 502 | 229,265 | 659 | 19,000 | 1,161 | 248,265 |
| 1920 | 1,245 | 661,907 | 403 | 16,324 | 1,648 | 678,231 |
| 1921 | 438 | 313,268 | 393 | 23,700 | 831 | 336,968 |
| 1922 | 25 | 3,320 | 42 | 6,800 | 67 | 10,120 |

## IMPORTS.

*Asbestos (unmanufactured) imported into the United States, 1918–1922, by countries, in short tons.*

[General imports.]

| Country. | 1918 | 1919 | 1920 | 1921 | 1922 | |
|---|---|---|---|---|---|---|
| | | | | | Short tons. | Value. |
| Africa: | | | | | | |
| British South Africa | 837 | 900 | 2,233 | 504 | 411 | $59,817 |
| Portuguese Africa | 2,049 | 100 | 1,584 | 279 | 138 | 33,008 |
| Australia | | | 3 | 1 | 8 | 7,051 |
| Canada | 134,813 | 133,662 | 162,717 | 71,412 | 147,596 | 4,745,296 |
| Chile | | | | 1 | | |
| China | | 1 | 17 | 50 | (a) | 128 |
| Colombia | 1 | | | | | |
| England | | 156 | 746 | 200 | 1,273 | 299,358 |
| France | | 450 | | | | |
| Germany | | | | 11 | (a) | 2 |
| Greece | | | 81 | | | |
| Hongkong | | | | 1 | | |
| India, British | | 1 | | | | |
| Italy | | | 3 | 2 | 1 | 40 |
| Japan | | | 100 | 1 | | |
| Trinidad and Tobago | | | | 1 | | |
| Turkey in Asia | | | 74 | | | |
| Total value | 137,700 $6,337,585 | 135,270 $7,369,685 | 167,558 $9,120,253 | 72,463 $2,948,302 | 149,427 $5,144,700 | 5,144,700 |

a Less than 1 ton.

## ASPHALT AND RELATED BITUMENS.

### PRODUCTION.

*Asphalt, produced in the United States from domestic petroleum, sold in 1917–1922.*

| Year. | Short tons. | Value. | Year. | Short tons. | Value. |
|---|---|---|---|---|---|
| 1917 | 701,809 | $7,734,691 | 1920 | 700,496 | $11,985,457 |
| 1918 | 604,723 | 8,796,541 | 1921 | 624,220 | 9,048,221 |
| 1919 | 614,692 | 8,727,372 | 1922 | 805,145 | 10,385,925 |

*Asphalt, produced in the United States from Mexican petroleum, sold in 1917–1922.*

| Year. | Short tons. | Value. | Year. | Short tons. | Value. |
|---|---|---|---|---|---|
| 1917 | 645,613 | $7,441,813 | 1920 | 1,045,779 | $14,272,862 |
| 1918 | 597,697 | 9,417,818 | 1921 | 908,093 | 11,761,358 |
| 1919 | 674,876 | 7,711,510 | 1922 | 1,242,163 | 13,899,407 |

*Native asphalt and related bitumens, produced in the United States, sold in 1917–1922.*

| Year. | Short tons. | Value. | Year. | Short tons. | Value. |
|---|---|---|---|---|---|
| 1917 | 81,604 | $773,424 | 1920 | 198,497 | $1,213,908 |
| 1918 | 60,034 | 780,808 | 1921 | 296,412 | 1,985,583 |
| 1919 | 88,281 | 682,989 | 1922 | 327,792 | 2,253,180 |

## IMPORTS AND EXPORTS.

*Asphalt and related bitumens imported for consumption in the United States, 1918–1922.*

| Year. | Crude asphalt. | | Ozokerite. | |
|---|---|---|---|---|
| | Short tons. | Value. | Short tons. | Value. |
| 1918 | 114,686 | $624,967 | 905 | $147,805 |
| 1919 | 104,913 | 609,923 | 1,874 | 454,840 |
| 1920 | 127,027 | 1,055,951 | 2,136 | 499,758 |
| 1921 | 116,450 | 972,166 | 4,274 | 546,054 |
| 1922 | 120,359 | 940,875 | 4,495 | 371,161 |

| Year. | Ichthyol. | | Bituminous limestone. | | Total | |
|---|---|---|---|---|---|---|
| | Short tons. | Value. | Short tons. | Value. | Short tons. | Value. |
| 1918 | 33 | $39,452 | 39 | $2,528 | 115,663 | $814,752 |
| 1919 | 15 | 38,975 | 735 | 5,576 | 107,537 | 1,109,314 |
| 1920 | 49 | 79,133 | 1,387 | 11,665 | 130,599 | 1,646,507 |
| 1921 | 38 | 107,752 | 12,085 | 157,124 | 132,847 | 1,783,096 |
| 1922 | 37 | 89,150 | 4,300 | 59,590 | 129,191 | 1,460,774 |

*Asphalt exported from the United States, 1918–1922.*

| Year. | Unmanufactured. | | Manufactures of (value). | Total value. |
|---|---|---|---|---|
| | Short tons. | Value. | | |
| 1918 | 22,108 | $577,654 | $577,936 | $1,155,590 |
| 1919 | 40,208 | 1,103,930 | 606,918 | 1,710,848 |
| 1920 | 51,706 | 1,356,116 | 842,074 | 2,198,190 |
| 1921 | 45,367 | 1,178,038 | 621,224 | 1,799,262 |
| 1922 | 57,362 | 1,344,440 | [a] 1,261,125 | [a] 2,605,565 |

[a] Includes value of 588,636 squares (10 by 10 feet) of roofing asphalt ($870,200). Corresponding exports not separately shown prior to 1922.

## BARYTES AND BARIUM PRODUCTS.

### BARYTES.

#### SUPPLY.

*Supplies of crude barytes in the United States, 1918–1922.*

| Year. | Domestic barytes sold. | | Imports for consumption. | | Apparent available supply.[a] | |
|---|---|---|---|---|---|---|
| | Short tons. | Value. | Short tons. | Value. | Short tons. | Value. |
| 1918 | 155,368 | $1,044,905 | | | 155,368 | $1,044,905 |
| 1919 | 209,330 | 1,727,822 | 118 | $594 | 209,448 | 1,728,416 |
| 1920 | 228,113 | 2,142,464 | 24,874 | 146,858 | 252,987 | 2,289,322 |
| 1921 | 66,369 | 531,958 | 11,054 | 59,371 | 77,423 | 591,329 |
| 1922 | 155,040 | 1,123,950 | 23,239 | 104,680 | 178,279 | 1,228,630 |

[a] No exports reported. Stocks at plants included, but those at mines excluded.

### PRODUCTION.

*Crude domestic barytes sold in the United States in 1921 and 1922, by States.*

| State. | 1921 | | 1922 | |
|---|---|---|---|---|
| | Short tons. | Value. | Short tons. | Value. |
| California | 942 | $5,084 | 3,338 | $17,707 |
| Georgia | 24,614 | 191,442 | 57,045 | 468,517 |
| Missouri | 25,200 | 217,913 | 66,421 | 421,568 |
| Tennessee | 8,180 | 61,148 | 16,642 | 124,204 |
| Other States [a] | 7,433 | 56,371 | 11,594 | 91,954 |
| | 66,369 | 531,958 | 155,040 | 1,123,950 |

[a] 1921: Alabama, Illinois, North Carolina, South Carolina, and Virginia; 1922: Alabama, Idaho, Illinois, North Carolina, and South Carolina.

### CONSUMPTION.

*Crude domestic and foreign barytes used in the manufacture of barium products in the United States, 1918–1922, in short tons.*

| Year. | In manufacture of— | | |
|---|---|---|---|
| | Ground barytes. | Lithopone. | Barium chemicals. |
| 1918 | 62,440 | 85,282 | 38,041 |
| 1919 | 64,922 | 103,688 | 32,976 |
| 1920 | 79,052 | 113,181 | 37,210 |
| 1921 | 28,296 | 61,359 | 10,952 |
| 1922 | 48,280 | 94,259 | 25,303 |

## BARIUM PRODUCTS.

### PRODUCTION.

*Barium products of domestic manufacture (from either domestic or imported crude ore) sold [a] in the United States, 1918–1922, in short tons.*

| Product. | 1918 | 1919 [a] | 1920 | 1921 | 1922 |
|---|---|---|---|---|---|
| Ground barytes | 55,086 | 57,985 | 65,748 | 27,661 | 46,176 |
| Lithopone | 62,403 | 79,643 | 89,373 | 55,016 | 83,360 |
| Barium chemicals [b] | 23,186 | 20,013 | 20,760 | 5,487 | 13,901 |
| | 140,675 | 157,641 | 175,881 | 88,164 | 143,437 |

[a] Figures for 1919 represent production.
[b] In order to avoid duplication of figures, barium chemicals manufactured from secondary products bought in open market are not included in table.

*Barium chemicals of domestic manufacture sold in the United States, 1918–1922, in short tons.*

| Chemical. | 1918 | 1919 | 1920 | 1921 | 1922 |
|---|---|---|---|---|---|
| Barium carbonate | 7,661 | 7,135 | 7,484 | 1,956 | 2,281 |
| Barium chloride | 4,530 | 4,509 | 3,084 | [a] | 2,022 |
| Barium sulphate (blanc fixe) | 9,522 | 5,227 | 8,046 | 2,471 | 5,740 |
| Other barium chemicals [b] | 1,473 | 3,142 | 2,146 | 1,060 | 3,858 |
| | 23,186 | 20,013 | 20,760 | 5,487 | 13,901 |

[a] Included under "Other barium chemicals."
[b] 1918: Binoxide, hydroxide, nitrate, and sulphide; 1919: Binoxide, nitrate, and sulphide; 1920: Binoxide, hydroxide, nitrate, and sulphide; 1921: Chloride, hydroxide, and sulphide; 1922: Binoxide, hydroxide, sulphide, sulphydrate, and titanox.

IMPORTS AND EXPORTS.

*Barium products imported for consumption in the United States, 1918–1922.*

| Product. | 1918 | 1919 | 1920 | 1921 | 1922 | |
|---|---|---|---|---|---|---|
| | | | | | Short tons. | Value. |
| Manufactured barytes | | | $3,017 | $16,942 | 4,696 | $59,453 |
| Lithopone | | $122,708 | 263,240 | 432,019 | 10,763 | 885,671 |
| Barium carbonate: | | | | | | |
| Natural (ground witherite) | $14,134 | 4,739 | 61,284 | 25,188 | 1,472 | 39,114 |
| Manufactured (chemically precipitated) | | 2,666 | 37,462 | 80,603 | 5,212 | 210,250 |
| Barium binoxide | | | 64,447 | 127,631 | 1,009 | 189,334 |
| Barium chloride | | 19,846 | 151,778 | 72,621 | 1,962 | 112,785 |
| Blanc fixe, or barium sulphate (chemically precipitated) | | 90 | 8,485 | 22,470 | 2,187 | 76,445 |
| | 14,134 | 150,049 | 589,713 | 777,474 | 27,301 | 1,573,052 |

Prior to 1922 barium products had not been exported in appreciable quantity, and no separate record of the exports was kept. Exports of lithopone in 1922 amounted to 1,616 short tons, valued at $169,982.

## BAUXITE AND ALUMINUM.

### BAUXITE.

*Bauxite supplies in the United States, 1918–1922.*

| Year. | Domestic production. | | | | | |
|---|---|---|---|---|---|---|
| | Georgia, Alabama, and Tennessee. | | Arkansas. | | Total. | |
| | Long tons. | Value. | Long tons. | Value. | Long tons. | Value. |
| 1918 | 42,829 | $314,112 | 562,892 | $3,133,880 | 605,721 | $3,447,992 |
| 1919 | 43,076 | 346,588 | 333,490 | 1,855,159 | 376,566 | 2,201,747 |
| 1920 | 40,029 | 349,453 | 481,279 | 2,897,892 | 521,308 | 3,247,345 |
| 1921 | 14,700 | 134,400 | 124,850 | 755,400 | 139,550 | 889,800 |
| 1922 | 42,810 | 329,440 | 266,790 | 1,682,890 | 309,600 | 2,012,330 |

| Year. | Imports. | | Exports.[a] | | Apparent available supply. | |
|---|---|---|---|---|---|---|
| | Long tons. | Value. | Long tons. | Value. | Long tons. | Value. |
| 1918 | 3,653 | $14,791 | 19,711 | $1,523,688 | 589,663 | $1,939,095 |
| 1919 | 6,082 | 36,820 | 17,701 | 1,372,094 | 364,947 | 866,473 |
| 1920 | 42,895 | 251,284 | 22,257 | 1,843,596 | 541,946 | 1,655,033 |
| 1921 | 27,587 | 164,589 | 5,942 | 488,785 | 161,195 | 565,604 |
| 1922 | 23,656 | 93,805 | 19,617 | 961,208 | 313,639 | 1,144,927 |

[a] Includes bauxite concentrates.

## ALUMINUM.

### PRODUCTION.

*Value of aluminum produced in the United States, 1917–1922.*[a]

| Year. | Primary metal. | Secondary metal. | Year. | Primary metal. | Secondary metal. |
|---|---|---|---|---|---|
| 1917 | $45,882,000 | $16,711,800 | 1920 | $41,375,000 | $9,489,100 |
| 1918 | 41,159,000 | 10,113,600 | 1921 | 10,906,000 | 3,775,400 |
| 1919 | 38,558,000 | 12,014,600 | 1922 | 13,622,000 | 6,085,900 |

[a] Value of primary metal based on average open-market price at New York for small lots, as quoted by the Engineering and Mining Journal-Press and that of secondary aluminum on average price at New York, as given by American Metal Market.

### IMPORTS AND EXPORTS.

*Aluminum imported for consumption in the United States, 1918–1922.*

| Year. | Crude and semicrude.[a] | | Manufactures of.[b] | Total value. |
|---|---|---|---|---|
| | Pounds. | Value. | | |
| 1918 | 1,690,683 | $533,704 | $20,882 | $554,586 |
| 1919 | 13,852,065 | 4,530,579 | 38,016 | 4,568,595 |
| 1920 | 39,298,649 | 12,183,891 | 893,131 | 13,077,022 |
| 1921 | 32,559,017 | 7,627,508 | 1,262,283 | 8,889,791 |
| 1922 | 43,892,588 | 8,287,344 | 1,407,668 | 9,695,012 |

[a] Includes crude aluminum, plates, sheets, wire, etc.
[b] Includes aluminum leaf, kitchen utensils, and all other manufactures of aluminum.

*Aluminum and manufactures of aluminum exported from the United States, 1918–1922.*

| Year. | Crude and semicrude.[a] | | Manufactures of. | Total value. |
|---|---|---|---|---|
| | Pounds. | Value. | | |
| 1918 | 24,135,234 | $8,979,315 | $1,890,073 | $10,869,388 |
| 1919 | 5,020,352 | 1,744,896 | 2,145,430 | 3,890,326 |
| 1920 | 9,407,631 | 3,067,617 | 2,563,164 | 5,630,781 |
| 1921 | 2,196,378 | 801,075 | 2,307,782 | 3,108,857 |
| 1922 | 4,347,020 | 1,127,460 | [b] 1,708,656 | 2,836,116 |

[a] Includes ingots, metal and alloys, plates and sheets, etc.
[b] Represents value of 4,544,949 pounds of tubes, moldings, castings, and other shapes, table, kitchen, or hospital utensils and other manufactures. Figures of quantity not available prior to 1922.

### PRICES.

*Average open-market price, small lots of aluminum, in the United States, 1917–1922, in cents per pound.*[a]

| | | | |
|---|---|---|---|
| 1917 | 51.59 | 1920 | 33.07 |
| 1918 | 33.42 | 1921 | [b] 26.10 |
| 1919 | 32.38 | 1922 | [b] 21.10 |

[a] Engineering and Mining Journal-Press quotations.
[b] Domestic aluminum; foreign grades 2 to 3 cents less.

## BISMUTH.

### PRODUCTION.

Bismuth was produced in 1922 by three firms operating plants for refining lead and tin bullion in the United States, but only one producer was willing to have his output published. About 300,000 pounds of bismuth has been recovered at refining plants each of the last two years, and half of it is considered foreign product.

### IMPORTS AND EXPORTS.

*Bismuth imported for consumption in the United States, 1917–1922.*

| Year. | Pounds. | Value. | Year. | Pounds. | Value. |
|---|---|---|---|---|---|
| 1917 | 69,250 | $142,300 | 1920 | 72,771 | $161,877 |
| 1918 | 135,700 | 277,273 | 1921 | 94,085 | 114,891 |
| 1919 | 57,607 | 55,179 | 1922 [a] | 121,505 | 239,777 |

[a] Also 9,392 pounds of "compounds, mixtures, and salts of bismuth," valued at $8,681, imported Sept. 22 to Dec. 31, 1922. Not separately classified prior to new tariff.

No exports of bismuth are recorded.

## BORAX.

[See Sodium compounds.]

## BRIQUETS (FUEL).

*Fuel briquets produced in the United States, 1917–1922.*

| Year. | Short tons. | Value. | Year. | Short tons. | Value. |
|---|---|---|---|---|---|
| 1917 | 406,856 | $2,233,888 | 1920 | 567,192 | $4,623,831 |
| 1918 | 477,235 | 3,212,793 | 1921 | 398,949 | 3,632,301 |
| 1919 | 295,734 | 2,301,054 | 1922 | 619,425 | 5,444,926 |

## BROMINE.

### PRODUCTION.

*Bromine, produced in the United States, sold in 1917–1922.*

| Year. | Pounds. | Value. | Year. | Pounds. | Value. |
|---|---|---|---|---|---|
| 1917 | 895,499 | $492,703 | 1920 | 1,160,584 | $745,381 |
| 1918 | 1,727,156 | 970,099 | 1921 | 711,953 | 172,759 |
| 1919 | 1,854,971 | 1,234,969 | 1922 | 1,005,174 | 150,668 |

### IMPORTS AND EXPORTS.

Imports of bromine in 1922 were 1,094 pounds, valued at $339, compared with 300 pounds, valued at $84, in 1921. None were recorded for 1920.

Exports are not specifically shown.

## CADMIUM.

### PRODUCTION.

*Metallic cadmium and cadmium sulphide produced in the United States, 1918–1922.*

| Year. | Metallic cadmium. | | Cadmium sulphide. | |
|---|---|---|---|---|
| | Pounds. | Value. | Pounds. | Value. |
| 1918 | 127,164 | $188,203 | 51,702 | $70,315 |
| 1919 | 99,939 | 121,926 | 31,197 | 37,436 |
| 1920 | 129,283 | 151,261 | 32,133 | 37,274 |
| 1921 | 68,501 | 67,131 | 65,446 | 71,336 |
| 1922 | [a]131,590 | [a]143,433 | 134,774 | 152,295 |

[a] Exclusive of cadmium in residues sold for export.

### IMPORTS AND EXPORTS.

Imports of cadmium in 1922 for consumption were 2,240 pounds, valued at $2,434, compared with 101 pounds, valued at $216 in 1921. No cadmium was imported from 1916 to 1920, inclusive.

Exports of cadmium are not separately recorded.

## CALCIUM CHLORIDE.

### PRODUCTION.

*Calcium-magnesium chloride from natural brines, produced in the United States, sold in 1917–1922.*

| Year. | Short tons. | Value. | Year. | Short tons. | Value. |
|---|---|---|---|---|---|
| 1917 | 30,503 | $451,480 | 1920 | 27,849 | $539,471 |
| 1918 | 26,624 | 503,452 | 1921 | 23,672 | 510,723 |
| 1919 | 26,123 | 321,596 | 1922 | 33,067 | 571,326 |

### IMPORTS AND EXPORTS.

Imports of calcium chloride from September 22 to December 31, 1922, amounted to 740 short tons, valued at $8,563. Imports were not separately shown prior to the new tariff.

Exports of calcium chloride are not specifically shown.

## CARBON BLACK.

*Carbon black produced from natural gas in the United States, 1919–1922.*

| Year. | Number of producers reporting. | Carbon black produced. | | Gas used (estimate) |
|---|---|---|---|---|
| | | Pounds. | Value. | M cubic feet. |
| 1919 | 17 | 52,056,941 | $3,816,040 | 49,896,000 |
| 1920 | 19 | 51,321,892 | 4,032,286 | 40,599,000 |
| 1921 | 23 | 59,766,315 | 5,445,878 | 50,565,000 |
| 1922 | 26 | 67,795,129 | 5,819,618 | 53,629,000 |

## CEMENT.

### PRODUCTION.

*Hydraulic cements shipped from mills in the United States, 1918–1922.*

| Year. | Masonry, natural, and puzzolan cements. | | Portland cement. | | Total. | |
|---|---|---|---|---|---|---|
| | Barrels. | Value. | Barrels. | Value. | Barrels. | Value. |
| 1918 | 432,966 | $401,341 | 70,915,508 | $113,316,275 | 71,348,474 | $113,717,616 |
| 1919 | 528,589 | 583,554 | 85,612,899 | 146,734,844 | 86,141,488 | 147,318,398 |
| 1920 | 767,481 | 1,150,890 | 96,311,719 | 194,439,025 | 97,079,200 | 195,589,915 |
| 1921 | 539,402 | 897,025 | 95,507,147 | 180,778,415 | 96,046,549 | 181,675,440 |
| 1922 | 889,428 | 1,293,598 | 117,701,216 | 207,170,430 | 118,590,644 | 208,464,028 |

*Portland cement produced in the United States, 1917–1922, in barrels.*

| | | | |
|---|---|---|---|
| 1917 | 92,814,202 | 1920 | 100,023,245 |
| 1918 | 71,081,663 | 1921 | 98,842,049 |
| 1919 | 80,777,935 | 1922 | 114,789,984 |

*Portland cement produced, shipped, and in stock in the United States, 1921 and 1922, by States.*

| State. | Production. | | | | Shipments. | | | | Stock (barrels). | |
|---|---|---|---|---|---|---|---|---|---|---|
| | Active plants. | | Barrels. | | 1921 | | 1922 | | 1921 (revised). | 1922 |
| | 1921 | 1922 | 1921 | 1922 | Barrels. | Value. | Barrels. | Value. | | |
| Alabama | 3 | 3 | 1,743,287 | 2,290,884 | 1,714,286 | $3,466,223 | 2,324,116 | $4,135,684 | 68,638 | 35,406 |
| California | 9 | 9 | 7,302,784 | 8,711,515 | 7,180,700 | 16,856,258 | 9,041,788 | 20,478,577 | 564,713 | 235,441 |
| Illinois | 4 | 4 | 5,587,825 | 6,407,129 | 5,237,510 | 9,092,982 | 6,554,945 | 10,584,171 | 772,955 | 625,139 |
| Iowa | 4 | 4 | 4,590,920 | 4,272,432 | 4,151,439 | 7,439,983 | 4,475,074 | 7,709,313 | 993,090 | 790,447 |
| Kansas | 7 | 7 | 3,781,494 | 4,634,287 | 3,643,582 | 7,253,944 | 4,556,517 | 8,138,268 | 540,877 | 618,647 |
| Michigan | 11 | 12 | 5,777,533 | 6,243,805 | 5,680,156 | 10,300,289 | 6,349,751 | 11,145,573 | 759,703 | 641,432 |
| Missouri | 5 | 5 | 4,446,091 | 6,170,633 | 4,375,712 | 8,034,540 | 6,239,144 | 10,457,557 | 640,932 | 572,444 |
| New York | 8 | 9 | 5,294,188 | 5,922,706 | 4,993,341 | 9,403,015 | 6,194,663 | 10,694,426 | 784,607 | 516,365 |
| Ohio | 5 | 5 | 2,563,773 | 2,835,243 | 2,518,723 | 4,615,492 | 2,913,034 | 5,243,687 | 238,678 | 161,797 |
| Pennsylvania | 22 | 22 | 27,628,598 | 33,276,093 | 26,622,367 | 46,881,625 | 34,023,695 | 55,528,002 | 3,410,698 | 2,659,452 |
| Texas | 5 | 5 | 2,668,741 | 3,628,756 | 2,514,045 | 5,902,863 | 3,730,477 | 7,515,932 | 296,296 | 190,762 |
| Washington | 4 | 4 | 1,678,863 | 1,942,781 | 1,612,891 | 4,080,785 | 1,951,414 | 4,684,624 | 255,293 | 246,660 |
| Other States [a] | 28 | 29 | 25,777,952 | 28,453,720 | 25,262,395 | 47,450,416 | 29,346,598 | 50,854,616 | 2,866,087 | 1,973,246 |
| | 115 | 118 | 98,842,049 | 114,789,984 | 95,507,147 | 180,778,415 | 117,701,216 | 207,170,430 | 12,192,567 | 9,267,238 |

[a] Colorado, Georgia, Indiana, Kentucky, Maryland, Minnesota, Montana, Nebraska, New Jersey, Oklahoma, Oregon, Tennessee, Utah, Virginia, and West Virginia.

*Portland cement produced, shipped, and in stock in the United States, 1921 and 1922, by districts.*

| Commercial district. | Production. | | | | Shipments. | | | | Stock (barrels). | |
|---|---|---|---|---|---|---|---|---|---|---|
| | Active plants. | | Barrels. | | 1921 | | 1922 | | 1921 (revised). | 1922 |
| | 1921 | 1922 | 1921 | 1922 | Barrels. | Value. | Barrels. | Value. | | |
| Eastern Pennsylvania, New Jersey, and Maryland | 22 | 22 | 25,571,726 | 31,195,617 | 24,841,973 | $44,110,573 | 31,897,649 | $51,953,144 | 2,998,155 | 2,294,497 |
| New York | 8 | 9 | 5,294,188 | 5,922,706 | 4,993,341 | 9,403,015 | 6,194,663 | 10,694,426 | 784,607 | 516,365 |
| Ohio, western Pennsylvania, and West Virginia | 10 | 10 | 9,501,895 | 10,753,301 | 9,185,858 | 15,947,184 | 11,040,908 | 18,586,754 | 1,151,043 | 862,361 |
| Michigan | 11 | 12 | 5,777,533 | 6,243,805 | 5,680,156 | 10,300,289 | 6,349,751 | 11,145,573 | 759,703 | 641,432 |
| Illinois, Indiana, and Kentucky | 10 | 10 | 17,050,741 | 17,998,914 | 16,423,356 | 28,468,092 | 18,676,656 | 30,159,728 | 2,102,438 | 1,424,096 |
| Virginia, Tennessee, Alabama, and Georgia | 7 | 8 | 5,065,854 | 5,954,043 | 4,916,245 | 9,879,466 | 6,158,652 | 10,854,347 | 374,105 | 169,506 |
| Eastern Missouri, Iowa, and Minnesota | 9 | 9 | 9,951,283 | 11,392,552 | 9,432,573 | 16,805,272 | 11,657,484 | 19,528,016 | 1,717,321 | 1,452,387 |
| Western Missouri, Nebraska, Kansas, and Oklahoma | 11 | 11 | 6,351,747 | 8,025,720 | 6,100,391 | 12,503,617 | 7,967,266 | 14,570,823 | 877,640 | 936,118 |
| Texas | 5 | 5 | 2,668,741 | 3,628,756 | 2,514,045 | 5,902,863 | 3,730,477 | 7,515,932 | 296,296 | 190,762 |
| Colorado and Utah | 5 | 5 | 1,860,573 | 2,020,784 | 1,806,931 | 4,330,333 | 2,063,500 | 4,609,605 | 215,579 | 172,857 |
| California | 9 | 9 | 7,302,784 | 8,711,515 | 7,180,700 | 16,856,258 | 9,041,788 | 20,478,577 | 564,713 | 235,441 |
| Oregon, Washington, and Montana | 8 | 8 | 2,444,984 | 2,942,271 | 2,431,578 | 6,271,453 | 2,922,422 | 7,073,505 | 350,967 | 370,816 |
| | 115 | 118 | 98,842,049 | 114,789,984 | 95,507,147 | 180,778,415 | 117,701,216 | 207,170,430 | 12,192,567 | 9,267,238 |

## IMPORTS AND EXPORTS.

*Cement imported into and exported from the United States, 1918–1922.*

| Year. | Imports for consumption. | | Exports. | |
|---|---|---|---|---|
| | Barrels. | Value. | Barrels. | Value. |
| 1918 | 305 | $1,200 | 2,252,446 | $5,912,166 |
| 1919 | 8,931 | 52,636 | 2,463,573 | 7,513,389 |
| 1920 | 524,604 | 1,254,729 | 2,985,807 | 10,045,369 |
| 1921 | 122,317 | 388,842 | 1,181,014 | 4,276,986 |
| 1922 | 355,931 | 692,429 | 1,127,845 | 3,206,201 |

## CHROMITE.

### SUPPLY.

*Supplies of chromite in the United States, 1918–1922.*

| Year. | Domestic shipments. | | Imports. | | Apparent available supply.[a] | |
|---|---|---|---|---|---|---|
| | Long tons. | Value. | Long tons. | Value. | Long tons. | Value. |
| 1918 | 82,430 | $3,955,567 | 100,142 | $2,892,825 | 182,572 | $6,848,392 |
| 1919 | 5,079 | 129,302 | 61,404 | 1,381,497 | 66,483 | 1,510,799 |
| 1920 | 2,502 | 44,857 | 150,275 | 1,921,824 | 152,777 | 1,966,681 |
| 1921 | 282 | 2,900 | 81,836 | 654,602 | 82,118 | 657,502 |
| 1922 | 355 | 7,288 | 90,081 | 741,186 | 90,436 | 748,474 |

[a] There are no exports of chromite.

### PRODUCTION.

*Crude chromite produced by different countries, 1918–1922, in metric tons.*

| Country. | 1918 | 1919 | 1920 | 1921 | 1922 |
|---|---|---|---|---|---|
| Australia [a] | 611 | 254 | 1,643 | 63 | [b] |
| Brazil [c] | 18,141 | 4,877 | 3,506 | | |
| Canada [d] | 19,952 | 7,748 | 9,993 | 2,538 | 986 |
| Cuba [c] | 8,963 | 14,693 | 721 | 610 | |
| Great Britain [e] | 142 | 152 | 1,118 | | [b] |
| Greece [f] | 2,640 | 4,070 | 12,492 | 5,919 | 10,000 |
| Guatemala [c] | 1,212 | 1,686 | 1,140 | 401 | |
| India [g] | 58,697 | 37,024 | 27,231 | 35,320 | 31,000 |
| Japan [h] | 6,247 | 6,012 | 3,969 | 3,368 | [b] |
| New Caledonia [i] | 55,177 | 23,548 | 91,534 | 29,458 | 20,000 |
| Norway [j] | 2,783 | 460 | | | [b] |
| Rhodesia [k] | 28,382 | 32,007 | 54,674 | 45,529 | 84,799 |
| Russia [l] | [b] | [b] | 2,965 | 4,013 | [b] |
| Turkey (Asia Minor) [m] | [b] | [b] | 25,000 | [b] | 2,540 |
| United States | 83,753 | 5,161 | 2,542 | 287 | 361 |
| Yugoslavia [n] | | | [b] | [b] | [b] |
| | 286,700 | 137,692 | 238,528 | 127,506 | 149,686 |

[a] New South Wales Dept. Mines Ann. Repts. Queensland Undersecretary for Mines Ann. Repts.
[b] Figures not yet available.
[c] Imports into United States, Bur. Foreign and Domestic Commerce.
[d] 1918–1920: Canada Dept. of Mines, Mines Branch, Ann. Repts.; 1921–1922: Dominion Bur. Statistics.
[e] 1918–1920: Mines and Quarries, General Repts., pt. 3; 1921: Sec. Mines and H. M. Chief Inspector Mines Dept. Ann. Rept.
[f] 1918: Information furnished by United States consulate general, Athens, Greece; 1919–1920: Tableaux statistiques du mouvement minier de la Gréce; 1921: Information furnished by Direction du Service des mines, Athens, Greece; 1922: Estimate.
[g] 1918–1921: India Geol. Survey Recs.; 1922: Estimate.
[h] 1918–1919: Japan Dept. Commerce, Bur. Mines; 1920–1921: Information from United States consulate, Yokohama, Japan.
[i] 1918: Statistique de l'industrie minéral en France et en Algérie; 1919–1921: Bull. Agence des colonies; 1922: Min. Jour., London. (Figures represent exports.)
[j] Norges Bergverksdrift.
[k] Rhodesia Secretary for Mines Repts.
[l] 1920: Min. Jour., London; 1921: U. S. Dept. Commerce, Commerce Repts., June 26, 1922.
[m] 1920: Estimate based largely on information furnished by E. J. Lavino & Co., importers; 1922: Estimate.
[n] Wray, D. A., report of geologist attached to the British Economic Mission to Serbia, 1921.

## IMPORTS.

*Crude chromite imported into the United States, 1918–1922, by countries, in long tons.*

| Country. | 1918 | 1919 | 1920 | 1921 | 1922 |
|---|---|---|---|---|---|
| Australia | 15,976 | 13,161 | 2,778 | ---------- | 4,000 |
| Belgium | ---------- | ---------- | 239 | ---------- | ---------- |
| Brazil | 17,854 | 4,800 | 3,451 | ---------- | ---------- |
| British South Africa | 521 | 29 | 39,400 | 23,318 | 41,602 |
| Canada | 20,949 | 8,941 | 8,491 | 7,554 | 801 |
| Cuba | 8,821 | 14,461 | 710 | 600 | 1 |
| England | 4 | ---------- | 3,799 | ---------- | 1,900 |
| French Oceania | 25,761 | 7,125 | 56,682 | 35,108 | 7,500 |
| Germany | ---------- | ---------- | 1 | ---------- | ---------- |
| Greece in Europe | ---------- | ---------- | 5,302 | 8,104 | 8,600 |
| Guatemala | 1,193 | 1,659 | 1,122 | 401 | ---------- |
| India | ---------- | ---------- | 4,500 | 928 | 12,677 |
| New Zealand | ---------- | 693 | ---------- | ---------- | ---------- |
| Other British Oceania | 1,063 | ---------- | ---------- | ---------- | ---------- |
| Portuguese Africa | 8,000 | 4,000 | 11,000 | ---------- | 11,100 |
| Spain | ---------- | 3,035 | 40 | ---------- | ---------- |
| Turkey in Asia | ---------- | 3,500 | 12,760 | 5,822 | [a] 2,500 |
| Turkey in Europe | ---------- | ---------- | ---------- | 1 | ---------- |
| | 100,142 | 61,404 | 150,275 | 81,836 | 90,081 |

[a] Listed by Bureau of Foreign and Domestic Commerce as Greece in Asia.

## CLAY.

### PRODUCTION.

*Domestic clay sold in the United States, 1918–1922, by kinds.*

| Year. | Kaolin, china clay, and paper clay. | | Ball clay. | | Slip clay. | | Fire clay. | |
|---|---|---|---|---|---|---|---|---|
| | Short tons. | Value. | Short tons. | Value. | Short tons. | Value. | Short tons. | Value. |
| 1918 | 179,694 | $1,459,529 | 89,896 | $590,631 | 13,552 | $49,898 | 2,305,033 | $5,664,064 |
| 1919 | 152,828 | 1,475,681 | 65,026 | 520,849 | 5,149 | 17,556 | 1,755,331 | 4,628,605 |
| 1920 | 268,203 | 2,865,407 | 69,477 | 584,611 | 9,006 | 41,519 | 2,261,915 | 7,088,049 |
| 1921 | 162,726 | 1,579,163 | 54,014 | 354,565 | 4,608 | 14,841 | 1,195,861 | 3,560,373 |
| 1922 | 275,675 | 2,346,095 | 76,792 | 440,877 | 4,050 | 19,405 | 1,679,220 | 4,633,486 |

| Year. | Stoneware clay. | | Miscellaneous clay. | | Total. | |
|---|---|---|---|---|---|---|
| | Short tons. | Value. | Short tons. | Value. | Short tons. | Value. |
| 1918 | 86,800 | $147,098 | 301,386 | $421,421 | 2,976,361 | $8,332,641 |
| 1919 | 60,236 | 80,367 | 236,530 | 367,573 | 2,275,100 | 7,090,631 |
| 1920 | 106,350 | 229,221 | 322,100 | 467,856 | 3,037,051 | 11,276,663 |
| 1921 | 86,574 | 184,540 | 242,963 | 361,818 | 1,746,746 | 6,055,300 |
| 1922 | 86,866 | 164,870 | 525,097 | 725,781 | 2,647,700 | 8,330,514 |

## IMPORTS AND EXPORTS.

*Clay imported for consumption in the United States, 1918–1922.*

| Year. | Kaolin or china clay. | | Common blue and Gross-Almerode glass-pot clay. | | All other clays. | | | | Total. | |
|---|---|---|---|---|---|---|---|---|---|---|
| | | | | | Unwrought. | | Wrought. | | | |
| | Short tons. | Value. | Short tons. | Value. | Short tons. | Value. | Short tons. | Value. | Short tons. | Value. |
| 1918 | 168,100 | $1,153,240 | 114 | $983 | 26,984 | $163,484 | 137 | $1,087 | 195,335 | $1,318,794 |
| 1919 | 180,592 | 1,965,393 | 4 | 133 | 23,759 | 187,550 | 498 | 4,262 | 204,853 | 2,157,338 |
| 1920 | 361,800 | 3,568,677 | 6,837 | 157,201 | 34,252 | 272,524 | 691 | 10,267 | 403,580 | 4,008,669 |
| 1921 | 162,906 | 1,546,285 | 4,468 | 77,217 | 41,421 | 348,870 | 120 | 2,313 | 208,915 | 1,974,685 |
| 1922 | 310,136 | 2,963,420 | 7,323 | 84,415 | 30,643 | 246,807 | 2,468 | 27,233 | 350,570 | 3,321,875 |

*Domestic clay exported from the United States, 1918–1922.*

| Year. | Kaolin, china clay, and paper clay. | | Fire clay. | | All other. | | Total. | |
|---|---|---|---|---|---|---|---|---|
| | Short tons. | Value. | Short tons. | Value. | Short tons. | Value. | Short tons. | Value. |
| 1918 | (a) | (a) | 60,206 | $333,880 | 24,348 | $192,053 | 84,554 | $525,933 |
| 1919 | (a) | (a) | 37,486 | 262,501 | 30,983 | 249,571 | 68,469 | 512,072 |
| 1920 | (a) | (a) | 54,125 | 393,177 | 66,035 | 775,222 | 120,160 | 1,168,399 |
| 1921 | (a) | (a) | 23,666 | 177,979 | 23,779 | 183,449 | 47,445 | 361,428 |
| 1922 | 2,091 | $27,840 | 24,391 | 169,664 | 21,194 | 240,068 | 47,676 | 437,572 |

[a] Not separately classified prior to 1922.

## CLAY PRODUCTS.

### PRODUCTION.

*Clay products of the United States, 1921 and 1922, by products.*[a]

| Product. | 1921 | | 1922 | |
|---|---|---|---|---|
| | Quantity. | Value. | Quantity. | Value. |
| Common brick ..... thousands | 4,550,937 | $57,083,313 | 5,898,898 | $72,612,999 |
| Vitrified brick or block ..... do | 561,316 | 12,870,165 | 517,287 | 10,815,574 |
| Face brick ..... do | 872,025 | 18,122,423 | 1,416,878 | 28,233,689 |
| Fancy or ornamental brick ..... do | 3,112 | 94,110 | 6,796 | 160,469 |
| Enameled brick ..... do | 12,696 | 1,203,161 | 15,380 | 1,296,651 |
| Architectural terra cotta ..... short tons | 68,360 | 9,068,473 | 107,224 | 12,409,543 |
| Fireproofing and hollow building tile ..... do | 2,017,643 | 14,841,745 | 2,870,308 | 19,707,614 |
| Tile (not drain) | | 12,558,406 | | 16,596,737 |
| Draintile ..... short tons | 965,418 | 8,243,567 | 594,843 | 5,148,987 |
| Sewer pipe ..... do | 1,408,877 | 22,275,697 | 1,422,162 | 23,599,649 |
| Stove lining | | 792,253 | | 1,224,068 |
| Fire brick ..... thousands | 621,222 | 24,833,297 | 836,724 | 31,356,741 |
| Miscellaneous | | 4,308,156 | | 6,345,385 |
| Total brick and tile | | 186,294,766 | | 229,508,106 |
| Total pottery | | 84,102,988 | | 91,986,297 |
| Grand total | | 270,397,754 | | 321,494,403 |

[a] Canvass discontinued by Geological Survey after 1920. Figures obtained through cooperation with Bureau of the Census.

*Value of clay products of the United States, 1921 and 1922, by States.*[a]

| State. | 1921 | | | | 1922 | | | |
|---|---|---|---|---|---|---|---|---|
| | Number of firms reporting. | Brick and tile. | Pottery. | Total. | Number of firms reporting. | Brick and tile. | Pottery. | Total. |
| Alabama | 49 | $2,243,842 | $22,862 | $2,266,704 | 39 | $2,772,155 | $26,100 | $2,798,255 |
| Arizona | 9 | 154,543 | ---- | 154,543 | 6 | 123,780 | ---- | 123,780 |
| Arkansas | 18 | 731,668 | (b) | [b] 731,668 | 15 | 976,111 | (b) | [b] 976,111 |
| California | 63 | 9,423,771 | 1,748,720 | 11,172,491 | 62 | 12,680,942 | 2,008,888 | 14,689,830 |
| Colorado | 43 | 2,488,806 | 252,862 | 2,741,668 | 36 | 3,142,537 | 288,660 | 3,431,197 |
| Connecticut and Rhode Island | 30 | 1,707,409 | (b) | [b] 1,707,409 | 24 | 2,675,150 | (b) | [b] 2,675,150 |
| Delaware | 11 | 208,154 | ---- | 208,154 | 10 | 219,633 | ---- | 219,633 |
| District of Columbia | 4 | 138,188 | (b) | [b] 138,188 | 4 | 235,453 | (b) | [b] 235,453 |
| Florida and Porto Rico | 14 | 166,609 | 12,200 | 178,809 | 11 | 174,578 | (b) | [b] 174,578 |
| Georgia | 46 | 3,342,235 | 15,139 | 3,357,374 | 35 | 4,141,688 | 15,913 | 4,157,601 |
| Idaho | 8 | 78,653 | ---- | 78,653 | 6 | 128,259 | ---- | 128,259 |
| Illinois | 143 | 16,994,260 | 2,046,922 | 19,041,182 | 119 | 23,041,251 | 3,743,012 | 26,784,263 |
| Indiana | 135 | 8,264,592 | 2,934,432 | 11,199,024 | 107 | 10,451,027 | 3,491,112 | 13,942,139 |
| Iowa | 103 | 5,711,583 | (b) | [b] 5,711,583 | 69 | 5,739,449 | (b) | [b] 5,739,449 |
| Kansas | 27 | 3,739,594 | ---- | 3,739,594 | 28 | 3,715,819 | ---- | 3,715,819 |
| Kentucky | 45 | 4,131,506 | 191,275 | 4,322,781 | 39 | 4,986,502 | (b) | [b] 4,986,502 |
| Louisiana | 17 | 587,868 | (b) | [b] 587,868 | 14 | 578,615 | (b) | [b] 578,615 |
| Maine | 17 | 631,480 | ---- | 631,480 | 14 | 768,725 | ---- | 768,725 |
| Maryland | 32 | 1,850,670 | 691,218 | 2,541,888 | 27 | 2,645,271 | 950,733 | 3,596,004 |
| Massachusetts | 37 | 1,614,610 | 415,779 | 2,030,389 | 33 | 1,984,067 | 518,547 | 2,502,614 |
| Michigan | 44 | 2,915,919 | 1,781,923 | 4,697,842 | 34 | 2,306,868 | 1,989,345 | 4,296,213 |
| Minnesota | 31 | 2,482,286 | (b) | [b] 2,482,286 | 25 | 2,201,502 | (b) | [b] 2,201,502 |
| Mississippi | 26 | 718,276 | 19,691 | 737,967 | 21 | 645,721 | 46,058 | 691,779 |
| Missouri | 65 | 10,579,034 | 89,657 | 10,668,691 | 59 | 11,649,495 | 96,513 | 11,746,008 |
| Montana | 10 | 175,386 | ---- | 175,386 | 10 | 290,781 | ---- | 290,781 |
| Nebraska | 27 | 779,087 | (b) | [b] 779,087 | 20 | 857,185 | (b) | [b] 857,185 |
| Nevada | 1 | (c) | ---- | (c) | 1 | (c) | ---- | (c) |
| New Hampshire | 13 | 436,724 | (b) | [b] 436,724 | 12 | 603,322 | ---- | 603,322 |
| New Jersey | 118 | 11,421,609 | 15,793,076 | 27,214,685 | 116 | 17,243,445 | 20,881,443 | 38,124,888 |
| New Mexico | 4 | 267,698 | ---- | 267,698 | 3 | (c) | ---- | (c) |
| New York | 115 | 10,643,031 | 6,789,055 | 17,432,086 | 105 | 14,862,925 | 5,685,884 | 20,548,809 |
| North Carolina | 71 | 2,275,273 | 14,250 | 2,289,523 | 69 | 2,999,822 | 12,488 | 3,012,310 |
| North Dakota | 3 | 160,949 | ---- | 160,949 | 3 | 173,715 | ---- | 173,715 |
| Ohio | 399 | 34,164,944 | 33,231,736 | 67,396,680 | 353 | 38,128,927 | 33,218,387 | 71,347,314 |
| Oklahoma | 21 | 1,796,666 | ---- | 1,796,666 | 19 | 1,935,570 | ---- | 1,935,570 |
| Oregon | 22 | 471,472 | (b) | [b] 471,472 | 13 | 569,289 | (b) | [b] 569,289 |
| Pennsylvania | 312 | 26,614,725 | 5,549,447 | 32,164,172 | 275 | 35,760,030 | 5,923,014 | 41,683,044 |
| South Carolina | 24 | 676,430 | 13,233 | 689,663 | 18 | 884,513 | (b) | [b] 884,513 |
| South Dakota | 2 | (c) | ---- | (c) | 2 | (c) | ---- | (c) |
| Tennessee | 41 | 2,728,419 | 243,029 | 2,971,448 | 31 | 2,774,727 | 1,503,543 | 4,278,270 |
| Texas | 61 | 3,861,389 | 114,747 | 3,976,136 | 55 | 4,284,861 | 91,540 | 4,376,401 |
| Utah | 15 | 1,057,678 | (b) | [b] 1,057,678 | 12 | 860,433 | (b) | [b] 860,433 |
| Vermont | 1 | (c) | ---- | (c) | 1 | (c) | ---- | (c) |
| Virginia | 43 | 2,545,883 | 18,000 | 2,563,883 | 36 | 2,845,510 | (b) | [b] 2,845,510 |
| Washington | 31 | 1,447,735 | 49,006 | 1,496,741 | 28 | 1,939,720 | 43,039 | 1,982,759 |
| West Virginia | 49 | 2,705,293 | 11,030,879 | 13,736,172 | 44 | 3,158,123 | 9,821,258 | 12,979,381 |
| Wisconsin | 42 | 765,644 | (b) | [b] 765,644 | 32 | 926,536 | (b) | [b] 926,536 |
| Wyoming | 7 | 252,401 | ---- | 252,401 | 3 | (c) | ---- | (c) |
| Undistributed | ---- | 140,774 | 1,033,850 | 1,174,624 | ---- | 424,074 | 1,630,820 | 2,054,894 |
| | 2,449 | 186,294,766 | 84,102,988 | 270,397,754 | 2,098 | 229,508,106 | 91,986,297 | 321,494,403 |

[a] Figures obtained through cooperation with Bureau of the Census.
[b] Pottery included under "Undistributed."
[c] Included under "Undistributed."

## IMPORTS AND EXPORTS.

*Value of clay products imported for consumption in the United States, 1918–1922.*

| Year. | Pottery. | | | | | | | | Brick, fire brick, tile, and miscellaneous clay products. | Grand total. |
|---|---|---|---|---|---|---|---|---|---|---|
| | Brown earthen and common stone ware.[a] | Tobacco pipes and pipe bowls of clay. | Earthenware and crockery composed of a non-vitrified absorbent body. | | China and porcelain. | | Sanitary earthenware decorated and not decorated. | Total. | | |
| | | | Decorated. | Not decorated. | Decorated. | Not decorated. | | | | |
| 1918 | $436,207 | $4,716 | $2,147,486 | $317,501 | $3,269,008 | $200,328 | $18,334 | $6,393,580 | $290,620 | $6,684,200 |
| 1919 | 293,120 | 15,852 | 2,476,210 | 350,644 | 3,726,695 | 359,560 | 7,980 | 7,230,061 | 196,839 | 7,426,900 |
| 1920 | 390,962 | 12,091 | 3,805,955 | 340,676 | 5,856,384 | 431,636 | 13,068 | 10,850,772 | 252,656 | 11,103,428 |
| 1921 | 288,893 | 11,535 | 3,871,554 | 405,370 | 6,918,179 | 646,427 | 12,067 | 12,154,025 | 228,804 | 12,382,829 |
| 1922 | 341,997 | 15,638 | 4,427,001 | 339,066 | 6,298,440 | 641,261 | 17,295 | 12,080,698 | 375,764 | 12,456,462 |

[a] Including Rockingham ware and miscellaneous pottery products.

*Value of clay products of domestic manufacture exported from the United States, 1918–1922.*

| Year. | Building brick. | Fire brick. | Tile (except drain). | Earthen and stone ware. | China. | Sanitary earthenware. | All other. | Total. |
|---|---|---|---|---|---|---|---|---|
| 1918 | $117,263 | $5,001,057 | $582,051 | $783,577 | $318,448 | $377,527 | $752,651 | $7,932,574 |
| 1919 | 248,690 | 2,747,512 | 628,836 | 1,148,051 | 523,861 | 563,734 | 721,600 | 6,582,284 |
| 1920 | 382,814 | 4,200,266 | 1,025,083 | 1,241,938 | 816,817 | 778,714 | 951,991 | 9,397,623 |
| 1921 | 415,402 | 2,314,911 | 814,456 | 1,014,329 | 312,161 | 535,506 | 873,182 | 6,279,947 |
| 1922 | 210,215 | 1,581,679 | 390,408 | 981,082 | 316,973 | 561,536 | [a]1,599,949 | 5,641,842 |

[a] Includes electric porcelain valued at $1,379,750; not separately classified prior to 1922.

## COAL.

### PRODUCTION.

*Coal produced in the United States, 1918–1922.*

| Year. | Pennsylvania anthracite. | | Bituminous. | | Total. | |
|---|---|---|---|---|---|---|
| | Short tons. | Value. | Short tons. | Value. | Short tons. | Value. |
| 1918 | 98,826,084 | $336,480,347 | 579,385,820 | $1,491,809,940 | 678,211,904 | $1,828,290,287 |
| 1919 | 88,092,201 | 364,926,950 | 465,860,058 | 1,160,616,013 | 553,952,259 | 1,525,542,963 |
| 1920 | 89,598,249 | 434,252,198 | 568,666,683 | 2,129,933,000 | 658,264,932 | 2,564,185,000 |
| 1921 | 90,473,451 | 452,304,903 | 415,921,950 | 1,199,983,600 | 506,395,401 | 1,652,288,600 |
| 1922 | 54,683,022 | 273,700,125 | 422,268,099 | 1,274,820,000 | 476,951,121 | 1,548,520,000 |

*Coal produced in the United States, 1921–1922, by States.*

| State. | 1921 (excluding wagon mines). | | 1922 (including wagon mines). | |
|---|---|---|---|---|
| | Short tons. | Value. | Short tons. | Value. |
| Alabama | 12, 568, 899 | $38, 713, 000 | 18, 324, 740 | $42, 856, 000 |
| Alaska | 76, 817 | 496, 000 | 79, 275 | 431, 000 |
| Arkansas | 1, 227, 777 | 5, 360, 000 | 1, 110, 046 | 4, 592, 000 |
| California, Idaho, and Oregon | 38, 845 | 181, 000 | 26, 893 | 104, 000 |
| Colorado | 9, 122, 760 | 32, 377, 000 | 10, 019, 597 | 31, 701, 000 |
| Georgia | 33, 815 | 171, 000 | 60, 636 | 246, 000 |
| Illinois | 69, 602, 763 | 190, 986, 000 | 58, 467, 736 | 168, 925, 000 |
| Indiana | 20, 319, 509 | 52, 269, 000 | 19, 132, 889 | 54, 524, 000 |
| Iowa | 4, 531, 392 | 17, 256, 800 | 4, 335, 161 | 16, 119, 000 |
| Kansas | 3, 466, 641 | 13, 333, 300 | 2, 955, 170 | 10, 816, 000 |
| Kentucky | 31, 588, 270 | 85, 092, 600 | 42, 134, 175 | 127, 037, 000 |
| Maryland | 1, 827, 740 | 6, 602, 000 | 1, 222, 707 | 4, 122, 000 |
| Michigan | 1, 141, 715 | 5, 555, 000 | 929, 390 | 4, 693, 000 |
| Missouri | 3, 551, 621 | 13, 915, 500 | 2, 924, 750 | 11, 153, 000 |
| Montana | 2, 733, 958 | 8, 921, 600 | 2, 572, 221 | 8, 208, 500 |
| New Mexico | 2, 453, 482 | 9, 585, 000 | 3, 147, 173 | 10, 977, 000 |
| North Carolina | 23, 438 | 135, 000 | 78, 570 | 388, 000 |
| North Dakota | 864, 903 | 2, 329, 500 | 1, 327, 564 | 3, 513, 000 |
| Ohio | 31, 942, 776 | 84, 686, 500 | 26, 953, 791 | 87, 056, 000 |
| Oklahoma | 3, 362, 623 | 15, 546, 000 | 2, 802, 511 | 11, 527, 000 |
| Pennsylvania (bituminous) | 116, 013, 942 | 322, 538, 300 | 113, 148, 308 | 351, 777, 000 |
| South Dakota | 7, 553 | 21, 200 | 7, 752 | 22, 000 |
| Tennessee | 4, 460, 326 | 14, 932, 000 | 4, 876, 774 | 14, 096, 000 |
| Texas | 972, 839 | 2, 563, 600 | 1, 106, 007 | 2, 563, 000 |
| Utah | 4, 078, 784 | 13, 662, 000 | 4, 992, 008 | 15, 687, 500 |
| Virginia | 7, 492, 378 | 22, 947, 700 | 10, 491, 174 | 27, 083, 000 |
| Washington | 2, 428, 722 | 9, 787, 000 | 2, 581, 165 | 10, 279, 000 |
| West Virginia | 72, 786, 996 | 206, 661, 500 | 80, 488, 192 | 236, 162, 000 |
| Wyoming | 7, 200, 666 | 23, 358, 500 | 5, 971, 724 | 18, 162, 000 |
| Total bituminous | 415, 921, 950 | 1, 199, 983, 600 | 422, 268, 099 | 1, 274, 820, 000 |
| Pennsylvania anthracite | 90, 473, 451 | 452, 304, 903 | 54, 683, 022 | 273, 700, 125 |
| Grand total | 506, 395, 401 | 1, 652, 288, 600 | 476, 951, 121 | 1, 548, 520, 000 |

*Coal produced in the United States in 1921 and 1922, by months, in short tons.*

| Month. | Pennsylvania anthracite. | | Bituminous. | |
|---|---|---|---|---|
| | 1921 | 1922 | 1921 | 1922 |
| January | 7, 681, 000 | 6, 566, 000 | 41, 148, 000 | 38, 930, 000 |
| February | 7, 983, 000 | 7, 096, 000 | 31, 524, 000 | 42, 425, 000 |
| March | 7, 677, 000 | 9, 181, 000 | 31, 054, 000 | 51, 936, 000 |
| April | 7, 985, 000 | 27, 000 | 28, 154, 000 | 16, 335, 000 |
| May | 7, 752, 000 | 36, 000 | 34, 057, 000 | 21, 005, 000 |
| June | 8, 071, 000 | 86, 000 | 34, 635, 000 | 23, 096, 000 |
| July | 7, 309, 000 | 118, 000 | 31, 047, 000 | 17, 602, 000 |
| August | 7, 459, 000 | 164, 000 | 35, 291, 000 | 26, 755, 000 |
| September | 7, 385, 000 | 5, 075, 000 | 35, 870, 000 | 42, 463, 000 |
| October | 7, 858, 000 | 8, 896, 000 | 44, 687, 000 | 46, 733, 000 |
| November | 7, 110, 000 | 8, 695, 000 | 36, 805, 000 | 46, 900, 000 |
| December | 6, 203, 000 | 8, 743, 000 | 31, 650, 000 | 48, 088, 000 |
| | 90, 473, 000 | 54, 683, 000 | 415, 922, 000 | 422, 268, 000 |

## IMPORTS AND EXPORTS.

*Coal imported into the United States, 1918–1922.*

| Year. | Anthracite. | | Bituminous. | | Total. | |
|---|---|---|---|---|---|---|
| | Short tons. | Value. | Short tons. | Value. | Short tons. | Value. |
| 1918 | 37,272 | $204,385 | 1,457,073 | $6,694,081 | 1,494,345 | $6,898,466 |
| 1919 | 82,818 | 522,419 | 1,011,550 | 4,950,686 | 1,094,368 | 5,473,105 |
| 1920 | 31,748 | 257,835 | 1,244,990 | 6,733,676 | 1,276,738 | 6,991,511 |
| 1921 | 8,894 | 93,103 | 1,257,589 | 7,363,945 | 1,266,483 | 7,457,048 |
| 1922 | 233,528 | 1,502,192 | 5,059,999 | 26,747,374 | 5,293,527 | 28,249,566 |

*Coal exported from the United States, 1918–1922.*

| Year. | Anthracite. | | Bituminous.[a] | | Total.[a] | |
|---|---|---|---|---|---|---|
| | Short tons. | Value. | Short tons. | Value. | Short tons. | Value. |
| 1918 | 4,967,808 | $29,215,689 | 22,350,730 | $78,664,856 | 27,318,538 | $107,880,545 |
| 1919 | 4,976,598 | 36,668,131 | 20,113,536 | 83,708,842 | 25,090,134 | 120,376,973 |
| 1920 | 5,403,749 | 45,538,100 | 38,517,084 | 304,273,241 | 43,920,833 | 349,811,341 |
| 1921 | 4,677,368 | 45,624,555 | 23,131,166 | 122,597,038 | 27,808,534 | 168,221,593 |
| 1922 | 2,649,457 | 25,350,677 | 12,413,085 | 65,891,740 | 15,062,542 | 91,242,417 |

[a] Exclusive of bunker coal, as follows: 1918, 6,196,036 short tons, valued at $29,868,023; 1919, 8,223,862 tons, $48,205,675; 1920, 10,485,639 tons, $82,461,518; 1921, 8,453,220 tons, $52,277,668; 1922, 4,614,632 tons, $27,912,957.

## COBALT.

### PRODUCTION.

Very little cobalt was produced in the United States during 1922. A carload of heterogenite (cobalt oxide) from Good Springs, Nev., mined in 1921, was shipped in 1922, and two other small shipments were made. The carload weighed 42,086 pounds, contained 4,018 pounds of cobalt, and sold for $1,419. No other cobalt ores are known to have been mined within the United States in either 1922 or 1921. In 1920 cobalt ores were mined only in Missouri, where the Missouri Cobalt Co. recovered 102,410 pounds of cobalt oxide and cobalt hydrate, valued at $262,801, from ore mined on its property near Fredericktown. The company operated only part of the year. In 1919 cobalt ores were mined in Idaho and Missouri. In Idaho the Haynes Stellite Co. produced concentrates carrying approximately 18 per cent of cobalt, and in Missouri the Missouri Cobalt Co. shipped cobalt oxide mined and reduced at its property near Fredericktown. In 1918 cobalt ores were mined only in Idaho where the Haynes Stellite Co. produced 55 tons of concentrates, carrying 17.74 per cent of cobalt (19,514 pounds), from 4,000 tons of ore.

### IMPORTS.

Most of the cobalt used in this country has been imported from Canada, where it is obtained as a by-product from silver ores mined in the Cobalt district.

*Cobalt ore, cobalt, zaffer, and oxide imported for consumption in the United States, 1919–1922.*

| Year. | Ore. | | Cobalt. | | Zaffer. | | Oxide. | | Total. | |
|---|---|---|---|---|---|---|---|---|---|---|
| | Pounds. | Value. | Pounds. | Value. | Pounds. | Value. | Pounds. | Value. | Pounds. | Value. |
| 1919 | 17,045 | $2,832 | 60,511 | $141,450 | ---------- | ---------- | 131,424 | $184,751 | 208,980 | $329,033 |
| 1920 | 13,039 | 4,794 | 143,603 | 326,864 | 220 | $14 | 202,724 | 399,605 | 359,586 | 731,277 |
| 1921 | 7,657 | 3,235 | 38,442 | 105,539 | ---------- | ---------- | 164,003 | 342,426 | 210,102 | 451,200 |
| 1922 | 5,195 | 7,075 | 126,364 | 321,396 | ---------- | ---------- | 217,530 | 435,895 | [a]349,089 | [a]764,366 |

[a] Also 11 pounds of "other salts and compounds," valued at $26, imported Sept. 22 to Dec. 31. Not separately classified prior to new tariff.

## COKE.

### PRODUCTION.

*Coke produced in the United States, 1918–1922.*

| Year. | By-product coke. | | | | Beehive coke. | | | | Total. | |
|---|---|---|---|---|---|---|---|---|---|---|
| | Quantity. | | Value. | | Quantity. | | Value. | | Short tons. | Value. |
| | Short tons. | Percentage of total. | Amount. | Percentage of total. | Short tons. | Percentage of total. | Amount. | Percentage of total. | | |
| 1918 | 25,997,580 | 46.0 | $193,018,785 | 50.5 | 30,480,792 | 54.0 | $189,305,583 | 49.5 | 56,478,372 | $382,324,368 |
| 1919 | 25,137,621 | 56.9 | 160,244,768 | 62.0 | 19,042,936 | 43.1 | 98,094,972 | 38.0 | 44,180,557 | 258,339,740 |
| 1920 | 30,833,951 | 60.0 | 313,028,732 | 65.8 | 20,511,092 | 40.0 | 162,952,483 | 34.2 | 51,345,043 | 475,981,215 |
| 1921 | 19,749,580 | 78.1 | 117,506,646 | 79.6 | 5,538,042 | 21.9 | 30,166,449 | 20.4 | 25,287,622 | 147,673,095 |
| 1922 | 28,550,545 | 76.9 | 188,276,767 | 79.0 | 8,573,467 | 23.1 | 50,036,556 | 21.0 | 37,124,012 | 238,313,323 |

*Coke produced in the United States, 1921 and 1922, by States.*

| State. | 1921 | | 1922 | |
|---|---|---|---|---|
| | Short tons. | Value.[a] | Short tons. | Value.[a] |
| Alabama | 2,534,039 | $12,256,085 | 3,799,865 | $14,708,245 |
| Colorado | 368,131 | 3,086,728 | 484,039 | 3,352,174 |
| Georgia | 6,943 | 80,828 | 8,832 | 74,807 |
| Illinois | 1,322,178 | 11,383,808 | 1,982,906 | 18,164,549 |
| Indiana | 3,091,263 | 19,007,519 | 3,995,505 | 28,978,431 |
| Kentucky | 284,825 | 1,863,707 | 487,167 | 3,614,140 |
| Maryland | 292,439 | [b] | 589,893 | [b] |
| Massachusetts | 294,059 | [b] | 407,081 | [b] |
| Michigan | 777,125 | 7,050,191 | 1,142,059 | 9,229,083 |
| Minnesota | 435,866 | 4,337,016 | 462,044 | 4,641,871 |
| Missouri | [c] | [c] | [c] | [c] |
| New Jersey | 739,768 | [b] | 790,811 | [b] |
| New Mexico | [c] | [c] | 87,631 | 788,679 |
| New York | 746,916 | 5,451,865 | 1,494,992 | 11,865,785 |
| Ohio | 3,028,423 | 16,272,453 | 5,011,138 | 33,100,323 |
| Pennsylvania | 9,769,476 | 44,111,831 | 13,991,892 | 74,794,560 |
| Rhode Island | [c] | [c] | [c] | [c] |
| Tennessee | 85,728 | 459,469 | 113,896 | 820,878 |
| Utah | [c] | [c] | 172,453 | 1,406,109 |
| Virginia | 280,476 | 2,029,652 | 378,656 | 2,291,336 |
| Washington | 27,260 | 194,510 | 31,674 | 285,881 |
| West Virginia | 397,892 | 2,253,044 | 919,744 | 6,112,387 |
| Wisconsin | [c] | [c] | [c] | [c] |
| Combined States | 804,815 | 7,550,873 | 771,734 | 7,520,701 |
| Undistributed | ---------- | 10,283,516 | ---------- | 16,563,384 |
| | 25,287,622 | 147,673,095 | 37,124,012 | 238,313,323 |

[a] Includes operators' statements of value for that portion of product not sold (such as coke consumed by producer in associated iron furnaces).
[b] Included under "Undistributed."
[c] Included under "Combined States."

*Beehive coke produced in the United States, 1921 and 1922, by States.*

| State. | 1921 | | 1922 | |
|---|---|---|---|---|
| | Short tons. | Value. | Short tons. | Value. |
| Alabama | 132, 912 | $794, 314 | 306, 209 | $1, 735, 406 |
| Colorado | 81, 376 | [a] | 119, 361 | 821, 309 |
| Georgia | 6, 943 | 80, 828 | 8, 832 | 74, 807 |
| Kentucky | 99, 442 | 766, 240 | 30, 522 | 216, 701 |
| Ohio | 62, 150 | 434, 950 | 99, 468 | 713, 186 |
| Pennsylvania | 4, 466, 105 | 22, 371, 288 | 6, 839, 980 | 38, 091, 586 |
| Tennessee | 28, 005 | 168, 794 | 86, 442 | 618, 542 |
| Virginia | 280, 476 | 2, 029, 652 | 378, 656 | 2, 291, 336 |
| Washington | 3, 495 | 34, 572 | 26, 063 | 241, 442 |
| West Virginia | 209, 537 | 1, 407, 166 | 417, 850 | 3, 037, 453 |
| New Mexico | 167, 601 | 1, 443, 672 | 87, 631 | 788, 679 |
| Utah | | | 172, 453 | 1, 406, 109 |
| Undistributed | | 634, 973 | | |
| | 5, 538, 042 | 30, 166, 449 | 8, 573, 467 | 50, 036, 556 |

[a] Included under "Undistributed."

*By-product coke produced in the United States, 1921 and 1922, by States.*

| State. | 1921 | | 1922 | |
|---|---|---|---|---|
| | Short tons. | Value. | Short tons. | Value. |
| Alabama | 2, 401, 127 | $11, 461, 771 | 3, 493, 656 | $12, 972, 839 |
| Colorado | 286, 755 | [a] | 364, 678 | [a] |
| Illinois | 1, 322, 178 | 11, 383, 808 | 1, 982, 906 | 18, 164, 549 |
| Indiana | 3, 091, 263 | 19, 007, 519 | 3, 995, 505 | 28, 978, 431 |
| Kentucky | 185, 383 | 1, 097, 467 | 456, 645 | 3, 397, 439 |
| Maryland | 292, 439 | [a] | 589, 893 | [a] |
| Massachusetts | 294, 059 | [a] | 407, 081 | [a] |
| Michigan | 777, 125 | 7, 050, 191 | 1, 142, 059 | 9, 229, 083 |
| Minnesota | 435, 866 | 4, 337, 016 | 462, 044 | 4, 641, 871 |
| New Jersey | 739, 768 | [a] | 790, 811 | [a] |
| New York | 746, 916 | 5, 451, 865 | 1, 494, 992 | 11, 865, 785 |
| Ohio | 2, 966, 273 | 15, 837, 503 | 4, 911, 670 | 32, 387, 137 |
| Pennsylvania | 5, 303, 371 | 21, 740, 543 | 7, 151, 912 | 36, 702, 974 |
| Tennessee | 57, 723 | 290, 675 | 27, 454 | 202, 336 |
| Washington | 23, 765 | 159, 938 | 5, 611 | 44, 439 |
| West Virginia | 188, 355 | 845, 878 | 501, 894 | 3, 074, 934 |
| Missouri | 637, 214 | 6, 107, 201 | 771, 734 | 7, 520, 701 |
| Rhode Island | | | | |
| Wisconsin | | | | |
| Undistributed | | 12, 735, 271 | | 19, 094, 249 |
| | 19, 749, 580 | 117, 506, 646 | 28, 550, 545 | 188, 276, 767 |

[a] Included under "Undistributed."

*Coke produced in the United States in 1921 and 1922, by months, in short tons.*

| Month. | 1921 | | 1922 | |
|---|---|---|---|---|
| | Beehive. | By-product. | Beehive. | By-product. |
| January | 1, 088, 000 | 2, 259, 000 | 529, 000 | 1, 886, 000 |
| February | 870, 000 | 1, 872, 000 | 586, 000 | 1, 800, 000 |
| March | 578, 000 | 1, 757, 000 | 781, 000 | 2, 137, 000 |
| April | 330, 000 | 1, 506, 000 | 564, 000 | 2, 206, 000 |
| May | 302, 000 | 1, 577, 000 | 465, 000 | 2, 544, 000 |
| June | 233, 000 | 1, 396, 000 | 491, 000 | 2, 594, 000 |
| July | 181, 000 | 1, 286, 000 | 476, 000 | 2, 501, 000 |
| August | 250, 000 | 1, 371, 000 | 567, 000 | 1, 822, 000 |
| September | 291, 000 | 1, 411, 000 | 649, 000 | 2, 249, 000 |
| October | 418, 000 | 1, 720, 000 | 935, 000 | 2, 812, 000 |
| November | 480, 000 | 1, 751, 000 | 1, 214, 000 | 2, 931, 000 |
| December | 517, 000 | 1, 844, 000 | 1, 316, 000 | 3, 069, 000 |
| | 5, 538, 000 | 19, 750, 000 | 8, 573, 000 | 28, 551, 000 |

## IMPORTS AND EXPORTS.

*Coke imported into and exported from the United States, 1918–1922.*

| Year. | Imports for consumption. | | Exports. | |
|---|---|---|---|---|
| | Short tons. | Value. | Short tons. | Value. |
| 1918 | 30,168 | $221,880 | 1,687,824 | $11,861,408 |
| 1919 | 16,486 | 140,653 | 716,956 | 5,128,119 |
| 1920 | 41,143 | 403,175 | 919,802 | 9,993,665 |
| 1921 | 30,990 | 336,394 | 306,755 | 2,760,939 |
| 1922 | 94,228 | 802,987 | 511,541 | 4,319,538 |

## COKE-OVEN BY-PRODUCTS.

*By-products from coke-oven operations in the United States, 1921–1922.*

| Product. | Produced. | Sold. | |
|---|---|---|---|
| | | Quantity. | Value. |
| **1921.** | | | |
| Tar—gallons | 253,051,649 | 135,293,047 | $5,645,309 |
| Ammonia: | | | |
| Sulphate—pounds | 528,638,763 | 530,041,716 | 13,100,703 |
| Ammonia liquor ($NH_3$ content)—do | 31,899,398 | 35,102,561 | 3,515,416 |
| Other forms ($NH_3$ content)—do | 191,162 | 53,993 | 10,135 |
| Sulphate equivalent of all forms—do | (657,001,003) | (670,667,932) | 16,626,254 |
| Gas: | | | |
| Distributed through city mains—M cu. ft | [a] 310,188,713 | 43,826,172 | 14,249,961 |
| Used in steel or affiliated plant—do | | 98,352,049 | 10,593,204 |
| Used under boilers, etc—do | | 12,122,777 | 1,120,087 |
| | | | 25,963,252 |
| Light oil and derivatives: | | | |
| Crude light oil—gallons | [b] 76,917,269 | 2,433,078 | 240,111 |
| Benzol, crude—do | 1,494,329 | 1,536,312 | 343,463 |
| Benzol, refined—do | 4,912,131 | 5,302,709 | 1,268,258 |
| Motor benzol—do | 48,052,882 | 50,022,573 | 8,966,686 |
| Toluol, crude—do | 26,529 | 26,529 | 4,410 |
| Toluol, refined—do | 942,982 | 808,964 | 228,968 |
| Solvent naphtha—do | 3,822,776 | 2,881,656 | 510,509 |
| Other light oil products—do | 590,173 | 291,635 | 12,310 |
| | | | 11,574,715 |
| Naphthalene, crude—pounds | 2,827,756 | 1,652,466 | 40,659 |
| Naphthalene, refined—do | 115,229 | 331,057 | 18,676 |
| | | | 59,335 |
| Other products | | | 121,813 |
| | | | [c] 59,990,678 |

[a] Inclusive of gas wasted and gas used for heating retorts.
[b] Of the crude light oil, 75,760,334 gallons in 1921 was refined on the premises to make the derived products listed.
[c] Exclusive of value of coke breeze.

*By-products from coke-oven operations in the United States, 1921–1922*—Continued.

| Product. | Produced. | Sold. | |
|---|---|---|---|
| | | Quantity. | Value. |
| **1922.** | | | |
| Tar, gallons | 327,779,734 | 162,204,417 | $6,419,743 |
| Ammonia: | | | |
| Sulphate, pounds | 695,543,349 | 714,752,882 | 17,818,236 |
| Ammonia liquor ($NH_3$ content), do | 50,036,646 | 48,523,937 | 4,559,535 |
| Other forms ($NH_3$ content), do | 693,782 | 192,549 | 12,041 |
| Sulphate equivalent of all forms, do | (898,465,061) | (909,618,826) | 22,389,812 |
| Gas: | | | |
| Distributed through city mains, M cu. ft | [a]442,671,114 | 56,930,253 | 20,326,648 |
| Used in steel or affiliated plant, do | | 144,976,030 | 15,942,446 |
| Used under boilers, etc., do | | 19,123,814 | 1,251,325 |
| Sold for industrial use, do | | 10,352,921 | 1,104,901 |
| | | | 38,625,320 |
| Light oil and derivatives: | | | |
| Crude light oil, gallons | [b]101,437,555 | 5,138,095 | 630,768 |
| Benzol, crude, do | 2,666,177 | 2,665,889 | 698,437 |
| Benzol, refined, do | 10,419,504 | 9,590,459 | 2,736,944 |
| Motor benzol, do | 57,025,699 | 54,930,203 | 10,491,309 |
| Toluol, crude, do | 38,159 | 3,938 | 652 |
| Toluol, refined, do | 1,955,119 | 1,906,122 | 556,363 |
| Solvent naphtha, do | 2,983,858 | 2,861,482 | 538,512 |
| Other light oil products, do | 580,058 | 212,712 | 14,949 |
| | | | 15,667,934 |
| Naphthalene, crude, pounds | 6,107,742 | 3,298,851 | 52,103 |
| Naphthalene, refined, do | 1,810,972 | 1,589,084 | 79,149 |
| | | | 131,252 |
| Other products | | | 154,507 |
| | | | [c]83,388,568 |

[a] Inclusive of gas wasted and gas used for heating retorts.
[b] Of the crude light oil, 98,432,100 gallons (including 4,200,000 gallons of purchased oil) in 1922 was refined on the premises to make the derived products listed.
[c] Exclusive of value of coke breeze.

## COPPER.

### SUMMARY OF STATISTICS.

*Summary of the statistics of the copper industry in the United States, 1920–1922.*

| | 1920 | 1921 | 1922 |
|---|---|---|---|
| Production of copper: | | | |
| Smelter output, pounds | 1,209,061,040 | 505,586,098 | 950,285,947 |
| Mine production, do | 1,224,550,151 | 466,190,853 | 964,583,894 |
| Refinery production of new copper— | | | |
| Electrolytic, do | 1,010,240,867 | 506,532,984 | 766,944,836 |
| Lake, do | 153,483,952 | 100,918,001 | 122,545,126 |
| Casting and pig, do | 18,698,421 | 1,963,271 | 15,180,723 |
| Total domestic, do | 1,182,423,240 | 609,414,256 | 904,670,685 |
| Total domestic and foreign, do | 1,634,908,644 | 1,020,027,096 | 1,358,659,101 |
| Total new and old copper, do | 2,260,000,000 | 1,455,000,000 | 2,030,000,000 |
| Ore produced: | | | |
| Copper ore, short tons | 36,765,370 | 13,396,382 | 26,893,247 |
| Average yield of copper, per cent | 1.63 | 1.70 | 1.74 |
| Average cost per pound of copper produced, cents | 14.94 | [a] | [a] |
| Other ore yielding copper, short tons | 26,890 | 14,248 | 52,370 |
| Average price per pound, cents | 18.4 | 12.9 | 13.5 |
| Imports (unmanufactured), pounds | 485,670,691 | 350,472,611 | 541,013,220 |
| Exports of metallic copper [b], do | 623,158,489 | 628,415,714 | 742,755,957 |
| Withdrawn from total supply on domestic account: | | | |
| Total new copper, pounds | 1,053,838,558 | 610,988,744 | 896,633,833 |
| Total new and old copper, do | 1,679,000,000 | 1,046,000,000 | 1,568,000,000 |
| Stocks at end of year: | | | |
| Blister and materials in solution, do | 465,000,000 | 283,000,000 | 361,000,000 |
| Refined copper, do | 659,000,000 | 459,000,000 | 216,000,000 |
| World's production, do | [a] | [a] | [a] |
| Value of smelter production from domestic ores | $222,467,000 | $65,221,000 | $128,289,000 |

[a] Figures not yet available.
[b] Total exports of copper, exclusive of ore, concentrates, and composition metal.

## PRODUCTION.

*Copper produced in the United States from domestic ores, 1919–1922.*

[Smelter output, in pounds fine.]

| State. | 1919 | 1920 | 1921 | 1922 |
|---|---|---|---|---|
| Alaska | 56, 534, 992 | 66, 093, 924 | 76, 808, 114 | 59, 900, 579 |
| Arizona | 536, 515, 368 | 552, 988, 731 | 155, 165, 656 | 428, 200, 634 |
| California | 23, 548, 698 | 11, 822, 028 | 15, 906, 883 | 20, 440, 430 |
| Colorado | 4, 892, 558 | 4, 282, 616 | 6, 592, 598 | 3, 635, 916 |
| Georgia | 8, 306 | 3, 663 | | 8, 147 |
| Idaho | 3, 966, 655 | 1, 922, 116 | 1, 971, 623 | 3, 504, 944 |
| Maine | 376, 186 | | 3 | |
| Michigan | 177, 594, 135 | 153, 483, 952 | 100, 918, 001 | 122, 545, 126 |
| Missouri | 588, 570 | 533, 368 | 137, 591 | 1, 070, 259 |
| Montana | 176, 289, 873 | 177, 743, 747 | 49, 471, 206 | 165, 341, 414 |
| Nevada | 64, 683, 734 | 55, 580, 322 | 15, 129, 116 | 20, 398, 611 |
| New Mexico | 60, 377, 320 | 52, 159, 751 | 18, 076, 909 | 29, 127, 329 |
| North Carolina | 3, 334 | | | |
| Oregon | 2, 808, 017 | 2, 529, 311 | 274, 934 | 925, 954 |
| Pennsylvania | | 618, 361 | | 888, 721 |
| South Carolina | 2, 297 | | | |
| South Dakota | 8, 631 | 2, 190 | | |
| Tennessee | 15, 629, 454 | 16, 727, 803 | 15, 084, 294 | 14, 226, 232 |
| Texas | 2, 153 | 14, 217 | 587 | 3, 889 |
| Utah | 143, 836, 304 | 110, 357, 748 | 45, 831, 959 | 79, 665, 563 |
| Vermont | 582, 561 | | | |
| Washington | 2, 552, 134 | 2, 125, 586 | 598, 658 | 369, 133 |
| Wyoming | 150, 051 | 24, 256 | 9, 830 | |
| Undistributed | 15, 467, 998 | 47, 350 | 3, 608, 136 | 33, 066 |
| | 1, 286, 419, 329 | 1, 209, 061, 040 | 505, 586, 098 | 950, 285, 947 |

*Primary and secondary copper produced by regular refining plants in the United States and imported, 1919–1922, in pounds.*

| | 1919 | 1920 | 1921 | 1922 |
|---|---|---|---|---|
| Primary: | | | | |
| Domestic [a] — | | | | |
| Electrolytic | 1, 233, 994, 324 | 1, 010, 240, 867 | 506, 532, 984 | 766, 944, 836 |
| Lake | 177, 594, 135 | 153, 483, 952 | 100, 918, 001 | 122, 545, 126 |
| Casting | 18, 223, 145 | 13, 905, 114 | 1, 740, 393 | 15, 180, 723 |
| Pig and best select | 3, 674, 191 | 4, 793, 307 | 222, 878 | |
| | 1, 433, 485, 795 | 1, 182, 423, 240 | 609, 414, 256 | 904, 670, 685 |
| Foreign [a] — | | | | |
| Electrolytic | [b] 370, 558, 779 | [b] 450, 194, 958 | [b] 405, 337, 490 | [b] 448, 784, 819 |
| Casting and best select | 1, 262, 227 | 2, 290, 446 | 5, 275, 350 | 5, 203, 597 |
| | 1, 805, 306, 801 | 1, 634, 908, 644 | 1, 020, 027, 096 | 1, 358, 659, 101 |
| Secondary: | | | | |
| Electrolytic | 32, 408, 548 | 31, 856, 549 | 82, 017, 382 | 100, 792, 685 |
| Casting | 38, 876, 481 | 49, 130, 510 | 24, 467, 951 | 45, 217, 857 |
| | 71, 285, 029 | 81, 987, 059 | 106, 485, 333 | 146, 010, 542 |
| Total output | 1, 876, 591, 830 | 1, 716, 895, 703 | 1, 126, 512, 429 | 1, 504, 669, 643 |

[a] The separation of refined copper into metal of domestic and foreign origin is only approximate, as an accurate separation at this stage of manufacture is not possible.
[b] Includes refined copper imported.

In addition to their output of metallic copper the regular refining companies produced in 1922 bluestone having a copper content of 8,508,000 pounds, as compared with 6,646,000 pounds in 1921.

## STOCKS.

*Stocks of copper January 1, 1918–1923, in pounds.*

| Year. | Refined copper. | Blister and material in process of refining. | Year. | Refined copper. | Blister and material in process of refining. |
|---|---|---|---|---|---|
| 1918 | 114,000,000 | 411,000,000 | 1921 | 659,000,000 | 465,000,000 |
| 1919 | 180,000,000 | 562,600,000 | 1922 | 459,000,000 | 283,000,000 |
| 1920 | 631,000,000 | 273,000,000 | 1923 | 216,000,000 | 361,000,000 |

## CONSUMPTION.

*New refined copper withdrawn from total year's supply on domestic account in the United States, 1919–1922, in pounds.*

| | 1919 | 1920 | 1921 | 1922 |
|---|---|---|---|---|
| Total supply of new copper | 1,805,306,801 | 1,634,908,644 | 1,020,027,096 | 1,358,659,101 |
| Stocks at beginning of year | 180,000,000 | 631,000,000 | 659,000,000 | 459,000,000 |
| Total available supply | 1,985,306,801 | 2,265,908,644 | 1,679,027,096 | 1,817,659,101 |
| Copper exported [a] | 439,835,229 | 553,070,086 | 609,038,352 | 705,025,268 |
| Stocks at end of year | 631,000,000 | 659,000,000 | 459,000,000 | 216,000,000 |
| Total withdrawn from supply | 1,070,835,229 | 1,212,070,086 | 1,068,038,352 | 921,025,268 |
| Withdrawn on domestic account | 914,471,572 | 1,053,838,558 | 610,988,744 | 896,633,833 |

[a] Includes unrefined black blister and converter copper (bars, pigs, and other forms) and refined in ingots, bars, rods, or other forms.

## IMPORTS AND EXPORTS.

*Copper imported into the United States, 1921 and 1922, in pounds.*

| Country. | Ore (copper content). | Concentrates (copper content). | Matte and regulus (copper content). | Unrefined black copper and copper in bars, pigs, or other forms. | Refined in bars, plates, rods, or other forms. | Old and clippings for remanufacture. | Composition metal, copper chief value. |
|---|---|---|---|---|---|---|---|
| **1921.** | | | | | | | |
| United Kingdom | 347,506 | | 26,400 | 3,721,557 | 12,404 | 1,216,687 | 484,151 |
| France | 647,591 | | 209,755 | 2,870,093 | 3,785,138 | 113,363 | 90,916 |
| Germany | 2,693,084 | | 3,844,157 | 5,207,032 | 95,032 | 60,345 | 294,653 |
| Spain | 4,475,091 | | 688,905 | 7,000 | | 220,792 | |
| Canada | 2,495,612 | 723,271 | 402,385 | 22,073,731 | 80,477 | 3,715,472 | |
| Mexico | 439,539 | 10,104,379 | 3,866,319 | 16,450,113 | 51,581 | 419 | |
| Cuba | 7,293,930 | 10,662,517 | | | | 84,661 | |
| Bolivia | 1,380,182 | | | | | | |
| Chile | 29,630,105 | 8,821,689 | 3,408,973 | 39,242,226 | 62,312,518 | | |
| Peru | 2,928,806 | 450,319 | 740,782 | 72,016,068 | | | |
| Venezuela | 1,383,377 | | 173,665 | | | 8,676 | |
| Australia | | | | 4,490,799 | | | |
| Br. South Africa | 1,256,602 | | 1,200,348 | | 460,852 | | |
| Portuguese Africa | 309,344 | | | 4,890,520 | 2,364,026 | | |
| Other countries | 1,397,179 | 12,171 | 785,937 | 766,140 | 87,253 | 286,481 | 111,515 |
| | 56,677,948 | 30,774,346 | 15,347,626 | 171,735,279 | 69,249,281 | 5,706,896 | 981,235 |
| **1922.** | | | | | | | |
| United Kingdom | 2,396,043 | 1,737,707 | 119,575 | 23,241,088 | 2,739,701 | 11,556,767 | 719,034 |
| France | 168,591 | 5,980 | 394,277 | 532,003 | 3,145,752 | 4,704,910 | |
| Germany | 1,114,096 | | 1,591,619 | | 708,514 | 277,153 | 175,662 |
| Spain | 7,001,731 | | 70,000 | 13,916,628 | | | |
| Canada | 2,567,149 | 696,296 | 283,703 | 46,211,714 | 7,532 | 3,522,162 | 2,810 |
| Mexico | 675,196 | 11,488,503 | 3,020,642 | 46,015,417 | 47,326 | 7,508 | |
| Cuba | 9,220,800 | 16,056,822 | | | | 683,393 | 9,111 |
| Bolivia | 436,153 | 643,907 | 345 | 884,622 | 20,312 | 18,745 | 31 |
| Chile | 44,041,453 | 2,073,710 | 142,261 | 44,215,265 | 96,433,739 | 103,784 | |
| Peru | 1,013,165 | 104,646 | 500,340 | 81,853,488 | 19,113 | 39,113 | |
| Venezuela | 901,421 | | 1,236,482 | | | 7,974 | |
| Australia | 24,408 | | | 1,850 | | | |
| Br. South Africa | 15,700 | 24,584 | | | | 30,899 | |
| Portuguese Africa | | 27,494 | | 44,398,268 | | | |
| Other countries | 1,627,220 | 48,022 | 1,368,795 | 1,308,885 | 21,153 | 389,007 | 203,951 |
| | 71,203,126 | 32,907,671 | 8,728,039 | 302,579,228 | 103,143,142 | 21,341,415 | 1,110,599 |

*Copper exported from the United States, 1920–1922, in pounds.*

| | 1920 | 1921 | 1922 |
|---|---|---|---|
| Ore (copper content) | 248,712 | 299,150 | 62,458 |
| Concentrates, matte, and regulus (copper content) | 192,194 | 60,970 | |
| Unrefined black blister and converter copper (bars, pigs, and other forms) | 1,843,293 | 150,313 | 169,733 |
| Refined ingots, bars, rods,[a] or other forms | 551,226,793 | 596,117,247 | 652,666,939 |
| Rods | [b] | [b] 12,770,792 | 52,188,596 |
| Composition metal, copper chief value | 454,306 | 28,916 | 221,473 |
| Old and scrap | 577,319 | 615,946 | 2,800,862 |
| Pipes and tubes | 4,899,223 | 2,248,503 | 1,822,580 |
| Plates and sheets | 22,799,148 | 5,105,916 | 6,748,454 |
| Wire | 41,812,713 | 11,406,997 | 11,600,480 |
| Insulated wire and cable | [c] | [c] | 8,575,745 |
| Other manufactures of copper | [c] | [c] | 6,182,568 |
| | 624,053,701 | 628,804,750 | 743,039,888 |

[a] Rods separately classified after July 1, 1921.
[b] Rods included under "Refined ingots, bars, rods, or other forms" prior to July 1, 1921, when separate classification was made.
[c] Not separately classified prior to 1922.

PRICES.

[See statement on page 14A.]

## CORUNDUM.

[See Abrasive materials.]

## CRYOLITE.

PRODUCTION.

No natural cryolite is produced in the United States, the entire supply used in this country being imported from Greenland. Small quantities of artificial cryolite are produced by electrochemical processes.

IMPORTS.

*Cryolite imported for consumption in the United States, 1917-1922.*

| Year. | Long tons. | Value. | Year. | Long tons. | Value. |
|---|---|---|---|---|---|
| 1917 | 4,383 | $218,500 | 1920 | 3,864 | $193,638 |
| 1918 | 1,950 | 97,500 | 1921 | 3,460 | 295,186 |
| 1919 | 2,131 | 106,956 | 1922 | 3,899 | 196,302 |

## DIATOMACEOUS (INFUSORIAL) EARTH.

[See Abrasive materials.]

## EMERY.

[See Abrasive materials.]

## FELDSPAR.

PRODUCTION.

*Crude feldspar, produced in the United States, sold in 1917–1922.*

| Year. | Long tons. | Value. | Year. | Long tons. | Value. |
|---|---|---|---|---|---|
| 1917 | 126,715 | $474,767 | 1920 | 135,551 | $851,123 |
| 1918 | 88,498 | 429,989 | 1921 | 91,865 | 617,652 |
| 1919 | 63,441 | 347,992 | 1922 | 117,127 | 844,568 |

*Feldspar, produced in Canada, sold in 1917–1922.*[a]

| Year. | Short tons. | Value. | Year. | Short tons. | Value. |
|---|---|---|---|---|---|
| 1917 | 19,462 | $89,826 | 1920 | 37,873 | $280,895 |
| 1918 | 18,782 | 112,728 | 1921 | 29,868 | 230,754 |
| 1919 | 14,679 | 86,231 | 1922 | 27,878 | 227,625 |

[a] 1917–1920: Canada Dept. Mines; 1921–1922: Dominion Bur. Statistics.

## IMPORTS AND EXPORTS.

The foreign trade of the United States in feldspar is small and limited largely to importing from Canada. Prior to September 22, 1922, imports of feldspar were not specifically classified in the official records. From that date to the end of the year the imports amounted to 7,549 long tons of crude feldspar, valued at $60,111, and 37 long tons of crushed or ground feldspar, valued at $538. There is no record of exports of feldspar, and if any they are doubtless negligible.

# FERROALLOYS.

## PRODUCTION.

*Ferroalloys shipped from furnaces in the United States, 1918–1922, in long tons.*

| Year. | Ferro-manganese. | Spiegel-eisen. | Other varieties. | Total. | |
|---|---|---|---|---|---|
| | | | | Quantity. | Value. |
| 1918[a] | 306,076 | 263,861 | 180,931 | 750,868 | $115,433,943 |
| 1919 | 198,255 | 90,855 | 130,528 | 419,638 | 53,730,964 |
| 1920 | 276,594 | 103,672 | 232,542 | 612,808 | 77,519,367 |
| 1921 | 111,374 | 69,230 | 68,023 | 248,627 | 21,697,785 |
| 1922 | 161,612 | 70,253 | 191,415 | 423,280 | 28,259,004 |

[a] The figures for 1918 fall short of the actual production of the United States, as the output of certain electrically produced ferroalloys is not available for publication by the Geological Survey.

*Ferroalloys shipped from furnaces in the United States in 1921 and 1922.*

| Variety of alloy. | 1921 | | 1922 | |
|---|---|---|---|---|
| | Long tons. | Value. | Long tons. | Value. |
| Ferromanganese [a] | 111,374 | $13,654,800 | 161,612 | $10,673,638 |
| Spiegeleisen | [b] 69,230 | [b] 2,838,692 | 70,253 | 2,162,836 |
| Ferrosilicon (7 per cent or more Si) | 55,099 | 2,548,827 | 154,866 | 7,109,928 |
| Ferromolybdenum | 19 | 43,866 | 108 | 267,168 |
| Ferrotungsten | 195 | 193,914 | 610 | 641,238 |
| Other varieties [c] | 12,710 | 2,417,686 | 35,831 | 7,404,196 |
| | 248,627 | 21,697,785 | 423,280 | 28,259,004 |

[a] Includes small quantity of silico-manganese.
[b] Includes small quantity of silico-spiegel.
[c] 1921: Ferrocarbide, ferrocerium, ferrochromium, ferrophosphorus, ferrotantalum-columbium, ferrotitanium, ferrovanadium, ferrozirconium, and zirconium-ferrosilicon; 1922: Ferrocarbide, ferrochromium, ferrophosphorus, ferrotitanium, ferrovanadium, ferrozirconium, and zirconium-ferrosilicon.

## IMPORTS AND EXPORTS.

*Ferroalloys imported for consumption in the United States, 1920–1922.*

| Variety of alloy. | 1920 | | 1921 | | 1922 | |
|---|---|---|---|---|---|---|
| | Long tons. | Value. | Long tons. | Value. | Long tons. | Value. |
| Chrome or chromium and ferrochromium | 1,751 | $428,619 | 452 | $106,669 | 397 | $118,870 |
| Ferrophosphorus | 6 | 780 | 5 | 132 | | |
| Ferrosilicon | 13,909 | 719,446 | 7,858 | 388,420 | 14,772 | 830,808 |
| Molybdenum and ferromolybdenum | | | (a) | 349 | 13 | 36,246 |
| Titanium and ferrotitanium | 1 | 713 | 2 | 1,299 | 24 | 11,607 |
| Tungsten and ferrotungsten | 892 | 1,180,829 | 226 | 180,371 | 477 | 394,727 |
| Ferrovanadium | 4 | 14,331 | | | (b) | 3,770 |
| Ferromanganese | 59,254 | 7,775,278 | 9,077 | 888,419 | 95,007 | 6,125,469 |
| Spiegeleisen | 5,234 | 277,900 | 307 | 10,472 | 8,151 | 268,135 |
| | 81,051 | 10,397,896 | 17,927 | 1,576,131 | 118,841 | 7,789,632 |

[a] 345 pounds. [b] 1,160 pounds.

*Ferroalloys exported from the United States, 1920–1922.*

| Variety of alloy. | 1920 | | 1921 | | 1922 | |
|---|---|---|---|---|---|---|
| | Long tons. | Value. | Long tons. | Value. | Long tons. | Value. |
| Ferromanganese | 3,454 | $642,570 | 690 | $100,474 | 1,107 | $76,822 |
| Spiegeleisen | (a) | (a) | (a) | (a) | 289 | 7,740 |
| Ferrochrome and chrome metal | (a) | (a) | (a) | (a) | 23 | 1,941 |
| Ferrosilicon | 632 | 41,057 | 368 | 20,204 | 689 | 30,939 |
| Tungsten and ferrotungsten | 2 | 5,913 | | | (b) | 43,219 |
| Ferrovanadium | 173 | 705,385 | 98 | 424,886 | 22 | 69,279 |

[a] Not separately classified prior to 1922. [b] 1,009 pounds.

## PRICES.

*Prices per ton of ferromanganese and spiegeleisen in the United States, 1920–1922, by months.*[a]

| Month. | Ferromanganese (80 per cent Mn., delivered at Pittsburgh). | | | Spiegeleisen (20 per cent Mn., at producer's furnace). | | |
|---|---|---|---|---|---|---|
| | 1920 | 1921 | 1922 | 1920 | 1921 | 1922 |
| January | $146.00 | $101.00 | $61.90 | $46.60 | $46.25 | $25.50 |
| February | 160.00 | 96.85 | 65.32 | 57.60 | 37.75 | 28.00 |
| March | 172.00 | 89.00 | 67.82 | 60.40 | 34.20 | 28.00 |
| April | 200.00 | 87.50 | 69.07 | 66.85 | 32.00 | 30.00 |
| May | 200.00 | 83.00 | 72.32 | 75.00 | 31.75 | 35.00 |
| June | 198.00 | 76.50 | 72.82 | 75.00 | 29.60 | 35.25 |
| July | 190.00 | 75.00 | 72.29 | 75.00 | 27.50 | 35.00 |
| August | 193.75 | 70.75 | 72.29 | 79.35 | 26.20 | 37.00 |
| September | 172.40 | 64.75 | 80.59 | 82.00 | 25.25 | 38.00 |
| October | 156.40 | 61.65 | 105.47 | 80.00 | 24.85 | 37.75 |
| November | 153.00 | 60.00 | 104.91 | 74.35 | 25.00 | 36.80 |
| December | 120.00 | 60.00 | 104.91 | 64.40 | 25.00 | 35.75 |

[a] Iron Trade Review.

## FLUORSPAR.

### SUPPLY.

*Supplies of fluorspar in the United States, 1918–1922.*

| Year. | Sales of domestic spar. | | Imports for consumption. | | Apparent available supply.[a] | |
|---|---|---|---|---|---|---|
| | Short tons. | Value. | Short tons. | Value. | Short tons. | Value. |
| 1918 | 263,817 | $5,465,481 | 12,572 | $169,364 | 276,389 | $5,634,845 |
| 1919 | 138,290 | 3,525,574 | 6,943 | 107,631 | 145,233 | 3,633,205 |
| 1920 | 186,778 | 4,718,547 | 24,612 | 265,630 | [a] 211,390 | [a] 4,984,177 |
| 1921 | 34,960 | 724,094 | 6,229 | 69,306 | 41,189 | 793,400 |
| 1922 | 141,596 | 2,531,165 | 33,108 | 299,188 | [a] 174,704 | [a] 2,830,353 |

[a] No exports have been reported by Bureau of Foreign and Domestic Commerce. Producers reported 2,764 tons, valued at $65,475, exported in 1920 and 2,296 tons, valued at $40,966, in 1922.

### PRODUCTION.

*Fluorspar shipped from mines in the United States, 1921 and 1922, by States.*

| State. | 1921 | | 1922 | |
|---|---|---|---|---|
| | Short tons. | Value. | Short tons. | Value. |
| Illinois | 12,477 | $315,767 | 83,855 | $1,493,188 |
| Kentucky | 15,266 | 294,513 | 52,484 | 970,059 |
| New Hampshire | 567 | 13,721 | } 768 | 16,757 |
| Utah | | | | |
| Colorado | 3,143 | 39,907 | 2,309 | 20,169 |
| New Mexico | 3,507 | 60,186 | 2,180 | 30,992 |
| | 34,960 | 724,094 | 141,596 | 2,531,165 |

## FULLER'S EARTH.

### PRODUCTION.

*Fuller's earth, produced in the United States, sold in 1917–1922.*

| Year. | Number of operators. | Short tons. | Value. | Year. | Number of operators. | Short tons. | Value. |
|---|---|---|---|---|---|---|---|
| 1917 | 11 | 72,567 | $772,087 | 1920 | 12 | 128,487 | $2,506,189 |
| 1918 | 14 | 84,468 | 1,146,354 | 1921 | 12 | 105,609 | 1,973,848 |
| 1919 | 10 | 106,145 | 1,998,829 | 1922 | 15 | 138,944 | 2,289,719 |

### IMPORTS AND EXPORTS.

*Fuller's earth imported for consumption in the United States, 1917–1922.*

| Year. | Short tons. | Value. | Year. | Short tons. | Value. |
|---|---|---|---|---|---|
| 1917 | 16,994 | $176,417 | 1920 | 19,015 | $221,893 |
| 1918 | 16,922 | 226,235 | 1921 | 9,744 | 119,415 |
| 1919 | 13,873 | 189,711 | 1922 | 10,569 | 135,695 |

Exports of fuller's earth are not reported separately.

## GARNET (ABRASIVE).

[See Abrasive materials.]

## GAS (NATURAL).

*Natural gas consumed in the United States, 1917–1922.*

| Year. | M cubic feet. | Value. | Year. | M cubic feet. | Value. |
|---|---|---|---|---|---|
| 1917 | 795, 110, 376 | $142, 089, 334 | 1920 | 798, 210, 000 | $196, 194, 000 |
| 1918 | 721, 000, 959 | 153, 553, 560 | 1921 | 662, 052, 000 | 174, 617, 000 |
| 1919 | 745, 916, 000 | 160, 888, 000 | 1922 | 762, 546, 000 | 221, 535, 000 |

*Natural gas produced in the United States and delivered to consumers, 1921–1922, by States.*

[Value is at point of consumption.]

| State. | 1921 | | 1922 | |
|---|---|---|---|---|
| | M cubic feet. | Value. | M cubic feet. | Value. |
| Arkansas | 4, 260, 000 | $984, 000 | 9, 700, 000 | $1, 798, 000 |
| California | 75, 942, 000 | 16, 496, 000 | 84, 580, 000 | 17, 898, 000 |
| Colorado | 4, 000 | 1, 000 | 4, 000 | 560 |
| Illinois | 2, 646, 000 | 356, 000 | 3, 383, 000 | 424, 040 |
| Indiana | 1, 066, 000 | 547, 000 | 947, 000 | 476, 172 |
| Iowa | 700 | 300 | 500 | 250 |
| Kansas | 15, 717, 000 | 7, 382, 000 | 20, 289, 000 | 9, 123, 000 |
| Kentucky | 4, 820, 000 | 1, 597, 000 | 5, 872, 000 | 1, 879, 000 |
| Louisiana | 58, 004, 000 | 5, 460, 000 | 70, 267, 000 | 5, 849, 000 |
| Maryland | 200 | 100 | | |
| Michigan | 400 | 300 | 700 | 350 |
| Missouri | 4, 000 | 3, 000 | 2, 600 | 2, 028 |
| Montana | 336, 000 | 89, 300 | 486, 000 | 88, 300 |
| New York | 6, 583, 000 | 2, 798, 000 | 6, 947, 000 | 3, 379, 000 |
| North Dakota | 1, 000 | 400 | 600 | 300 |
| Ohio | 47, 412, 000 | 19, 216, 000 | 51, 481, 000 | 24, 181, 000 |
| Oklahoma | 124, 058, 000 | 23, 429, 000 | 140, 631, 000 | 33, 475, 800 |
| Oregon | 200 | 100 | | |
| Pennsylvania | 86, 144, 000 | 32, 815, 000 | 101, 276, 000 | 39, 835, 000 |
| South Dakota | 9, 700 | 4, 000 | 15, 600 | 6, 400 |
| Tennessee | 11, 000 | 2, 600 | 3, 000 | 800 |
| Texas | 44, 504, 000 | 8, 893, 000 | 47, 945, 000 | 10, 623, 000 |
| West Virginia | 174, 920, 800 | 52, 827, 900 | 195, 288, 000 | 69, 464, 000 |
| Wyoming | 15, 608, 000 | 1, 715, 000 | 23, 427, 000 | 3, 031, 000 |
| | 662, 052, 000 | 174, 617, 000 | 762, 546, 000 | 221, 535, 000 |

## GASOLINE FROM NATURAL GAS.

*Natural-gas gasoline produced in the United States, 1918–1922.*

| Year. | Gasoline produced. | | Gas treated (estimated) (M cubic feet). |
|---|---|---|---|
| | Gallons. | Value. | |
| 1918 | 282, 535, 550 | $50, 363, 535 | 449, 109, 000 |
| 1919 | 351, 535, 026 | 64, 196, 763 | 480, 404, 000 |
| 1920 | 384, 743, 922 | 71, 788, 122 | 496, 431, 000 |
| 1921 | 449, 934, 402 | 61, 815, 258 | 465, 097, 000 |
| 1922 | 505, 832, 000 | 72, 711, 063 | 545, 139, 000 |

*Natural-gas gasoline produced in the United States, 1921 and 1922, by States.*

| State. | 1921 | | 1922 | |
|---|---|---|---|---|
| | Gallons. | Value. | Gallons. | Value. |
| Arkansas | | | 4,288,955 | $629,491 |
| California | 58,220,498 | $9,874,594 | 67,119,700 | 11,868,152 |
| Illinois | 7,536,073 | 1,101,227 | 7,760,011 | 1,181,797 |
| Kansas | 3,587,329 | 565,408 | 2,855,573 | 435,056 |
| Kentucky | 4,241,938 | 834,983 | 5,204,883 | 925,810 |
| Louisiana | 15,340,374 | 1,812,268 | 29,406,282 | 4,112,655 |
| New York | 366,240 | 52,108 | 506,200 | 61,415 |
| Ohio | 9,099,897 | 1,546,551 | 8,600,296 | 1,300,929 |
| Oklahoma | 185,340,742 | 22,066,014 | 189,403,670 | 24,914,048 |
| Pennsylvania | 19,856,373 | 3,354,233 | 18,518,131 | 3,144,545 |
| Texas | 77,141,201 | 9,118,420 | 95,405,483 | 12,114,952 |
| West Virginia | 54,646,053 | 9,889,861 | 56,795,713 | 9,770,884 |
| Wyoming | 14,557,684 | 1,599,591 | 19,967,103 | 2,251,329 |
| | 449,934,402 | 61,815,258 | 505,832,000 | 72,711,063 |

## GEMS AND PRECIOUS STONES.

### PRODUCTION.

*Value of precious stones produced in the United States, 1918–1922.*

| Variety. | 1918 | 1919 | 1920 | 1921 | 1922 |
|---|---|---|---|---|---|
| Agalmatolite | | | [a] | | |
| Andalusite | [a] | | | $10 | |
| Beryl | $1,906 | [a] | $3,440 | 1,090 | [a] |
| Calamine | [a] | | | | |
| Chlorastrolite | 146 | $53 | [a] | 100 | $100 |
| Copper-ore gems | 2,299 | [a] | [a] | 8,775 | 340 |
| Corundum (sapphire) | 42,414 | 40,304 | 214,705 | 482,745 | 50,727 |
| Datolite | [a] | [a] | [a] | | |
| Diamond | 1,910 | [a] | [a] | [b] | [b] 1,200 |
| Epidote | [a] | | [a] | | |
| Feldspar | [a] | [a] | 520 | 155 | 73 |
| Fluorite | [a] | | | | |
| Fossil coral | | [a] | | 200 | [a] |
| Garnet | 1,277 | 1,630 | 331 | 606 | 136 |
| Hematite | 138 | [a] | 45 | | |
| Iceland spar | [a] | [a] | 398 | [a] | 338 |
| Jet | | [a] | [a] | 460 | [a] |
| Lapis lazuli | [a] | [a] | | | |
| Mariposite | [a] | | | | |
| Meerschaum (sepiolite) | [a] | [a] | | | |
| Obsidian | [a] | | 40 | 67 | 6 |
| Olivine | 1,018 | | 100 | | |
| Opal | 6,304 | [a] | [a] | 336 | [a] |
| Phenacite | [a] | | | | |
| Pyrite | [a] | | [a] | | |
| Quartz | 15,211 | 17,632 | 14,676 | 11,114 | 5,318 |
| Rhodonite | 515 | 160 | [a] | 275 | [a] |
| Satin spar (gypsum) | [a] | | | | |
| Smithsonite | | | | [a] | |
| Spinel | | [a] | [a] | | [a] |
| Spodumene | 281 | [a] | | | [a] |
| Staurolite | [a] | | [a] | | |
| Thomsonite | [a] | [a] | 10 | 10 | [a] |
| Topaz | 907 | 210 | 767 | [a] | [a] |
| Tourmaline | 6,206 | 17,700 | 4,869 | 1,450 | 1,878 |
| Turquoise | 20,667 | 22,750 | 16,865 | 6,272 | 6,928 |
| Variscite | 753 | 925 | [a] | 560 | 658 |
| Vesuvianite | 320 | | | | |
| Willemite | [a] | | | | |
| Zircon | | | 144 | | |
| Zoisite | [a] | | | | [a] |
| Undistributed | 4,251 | 10,399 | 8,295 | 4,055 | 3,404 |
| | 106,523 | 111,763 | 265,205 | [b] 518,280 | [b] 71,106 |

[a] Included under "Undistributed."
[b] Data regarding Arkansas diamond output not available.

## IMPORTS AND EXPORTS.

*Value of diamonds and other precious stones imported for consumption in the United States, 1918–1922.*

| Year. | Diamonds. | | | | Other stones not set. | Total excluding pearls. | Pearls. |
|---|---|---|---|---|---|---|---|
| | Glazier's. | Dust and bort. | Rough or uncut. | Cut but not set. | | | |
| 1918 | $718,397 | $475,870 | $12,636,024 | $7,734,150 | $1,102,398 | $22,666,839 | $765,929 |
| 1919 | 984,381 | 1,420,442 | 20,306,758 | 64,085,610 | 5,161,639 | 91,958,830 | 11,008,973 |
| 1920 | 1,527,753 | 3,387,488 | 10,526,125 | 45,240,013 | 5,419,363 | 66,100,742 | 7,879,384 |
| 1921 | 435,872 | 466,345 | 2,207,365 | 26,144,323 | 2,778,931 | 32,032,836 | 4,492,063 |
| 1922 | 839,882 | 1,029,261 | 8,332,416 | 43,144,742 | 3,723,062 | 57,069,363 | 8,546,574 |

Domestic exports in 1922 were as follows: "Diamonds, cut but not set," 15 carats, valued at $1,540; "other precious stones, including pearls," $21,525. Data are not separately classified prior to 1922.

*Value of foreign precious stones reexported from the United States, 1918–1922.*

| Year. | Diamonds. | | | Other precious stones. | | Total excluding pearls. | Pearls and parts of, not strung or set. |
|---|---|---|---|---|---|---|---|
| | Uncut. | Cut but not set. | Bort. | Uncut. | Cut but not set. | | |
| 1918 | | | $56 | $100 | $57 | $213 | $42,908 |
| 1919 | $3,238 | $25,000 | (a) | [a] 15,653 | 1,783 | 45,674 | 5,386 |
| 1920 | | | (a) | [a] 4,604 | 13,338 | 17,942 | 8,000 |
| 1921 | | 896 | (a) | [a] 14,390 | 9,353 | 24,639 | 128 |
| 1922 | 19,735 | 1,396 | (a) | [a] 7,387 | 7,546 | 36,064 | 728 |

[a] Bort included under "Other precious stones—uncut."

## GOLD AND SILVER.

### PRODUCTION.

*Gold and silver produced in the United States, 1918–1922.*

| Year. | Gold. | | Silver. | |
|---|---|---|---|---|
| | Troy ounces. | Value. | Troy ounces. | Commercial value. |
| 1918 | 3,320,784 | $68,646,700 | 67,810,139 | $66,485,129 |
| 1919 | 2,918,628 | 60,333,400 | 56,682,445 | 63,533,652 |
| 1920 | 2,476,166 | 51,186,900 | 55,361,573 | 60,801,955 |
| 1921 | 2,422,006 | 50,067,300 | 53,052,441 | 53,052,441 |
| 1922 | 2,363,075 | 48,849,100 | 56,240,048 | 56,240,048 |

According to tables published by the Director of the Mint, the total production of gold and silver in the United States is as follows:

*Gold and silver produced in the United States, 1792–1922.*

[The estimate for 1792–1872 is by R. W. Raymond, commissioner, and for the period since 1872 by the Director of the Mint.]

| Period. | Gold. | | Silver. | |
|---|---|---|---|---|
| | Troy ounces. | Value. | Troy ounces. | Commercial value. |
| 1792–1847 | 1,186,977 | $24,537,000 | 309,500 | $404,500 |
| 1848–1872 | 58,279,781 | 1,204,750,000 | 118,568,200 | 157,749,900 |
| 1873–1922 | 143,311,146 | 2,962,504,300 | 2,549,806,385 | 2,036,972,525 |
| | 202,777,904 | 4,191,791,300 | 2,668,684,085 | 2,195,126,925 |

*Gold produced in the United States in 1921 and 1922, by States.*[a]

| State. | 1921 | | 1922 | |
|---|---|---|---|---|
| | Troy ounces. | Value.[b] | Troy ounces. | Value.[b] |
| Alabama | 4 | $100 | | |
| Alaska | 386,927 | 7,998,500 | 345,630 | $7,144,800 |
| Arizona | 160,498 | 3,317,800 | 169,704 | 3,508,100 |
| California | 728,590 | 15,061,300 | 712,157 | 14,721,600 |
| Colorado | 355,459 | 7,347,800 | 324,456 | 6,707,100 |
| Georgia | 53 | 1,100 | 140 | 2,900 |
| Idaho | 26,229 | 542,200 | 22,891 | 473,200 |
| Maine | 9 | 200 | | |
| Montana | 83,476 | 1,725,600 | 72,443 | 1,518,200 |
| Nevada | 155,791 | 3,220,500 | 160,044 | 3,308,400 |
| New Mexico | 9,824 | 203,100 | 19,553 | 404,200 |
| North Carolina | 82 | 1,700 | 73 | 1,500 |
| Oregon | 39,454 | 815,600 | 23,728 | 490,500 |
| Pennsylvania | 24 | 500 | 116 | 2,400 |
| Philippine Islands | 60,705 | 1,254,900 | 73,840 | 1,526,400 |
| South Carolina | | | 5 | 100 |
| South Dakota | 315,550 | 6,523,000 | 320,402 | 6,623,300 |
| Tennessee | 241 | 5,000 | 218 | 4,500 |
| Texas | 116 | 2,400 | 19 | 400 |
| Utah | 91,636 | 1,894,300 | 107,175 | 2,215,500 |
| Virginia | 29 | 600 | 34 | 700 |
| Washington | 7,309 | 151,100 | 9,394 | 194,200 |
| Wyoming | | | 53 | 1,100 |
| | 2,422,006 | 50,067,300 | 2,363,075 | 48,849,100 |

[a] Figures of production issued jointly by the Bureau of the Mint and the Geological Survey.
[b] Gold value, $20.67+a troy ounce.

*Silver produced in the United States in 1921 and 1922, by States, in troy ounces and dollars.*[a]

| State. | 1921 | 1922 |
|---|---|---|
| Alabama | 4 | |
| Alaska | 753,999 | 770,232 |
| Arizona | 2,519,200 | 4,627,738 |
| California | 3,606,708 | 3,095,480 |
| Colorado | 6,310,694 | 6,018,781 |
| Georgia | 3 | 394 |
| Idaho | 7,200,319 | 5,791,413 |
| Illinois | 1,616 | 4,612 |
| Michigan | 316,551 | 360,811 |
| Missouri | 63,470 | 118,655 |
| Montana | 9,677,020 | 9,682,304 |
| Nevada | 6,998,774 | 8,287,704 |
| New Mexico | 579,374 | 764,031 |
| North Carolina | 13 | 8 |
| Oregon | 53,118 | 150,347 |
| Pennsylvania | 1,707 | 2,141 |
| Philippine Islands | 26,392 | 27,994 |
| South Dakota | 111,670 | 121,427 |
| Tennessee | 106,664 | 76,885 |
| Texas | 548,827 | 653,657 |
| Utah | 14,028,661 | 15,465,202 |
| Virginia | 8 | 6 |
| Washington | 147,584 | 219,398 |
| Wyoming | 65 | 828 |
| | 53,052,441 | 56,240,048 |

[a] Figures of production issued jointly by the Bureau of the Mint and the Geological Survey. Valued at $1 an ounce, provided by the Pittman Act of Apr. 23, 1918, for domestic product.

## IMPORTS AND EXPORTS.

*Value of gold and silver imported into and exported from the United States, 1921 and 1922.*

| | Imports. | Exports. | Excess of— | |
|---|---|---|---|---|
| | | | Imports. | Exports. |
| **1921.** | | | | |
| Gold: | | | | |
| Contained in domestic ore and base bullion | | $77,413 | | $77,413 |
| Contained in foreign ore and base bullion | $33,564,537 | 476 | $33,564,061 | |
| Domestic bullion refined | 459,413 | 1,612,349 | | 1,152,936 |
| Foreign bullion refined | 503,136,371 | 2,005,408 | 501,130,963 | |
| United States coin | 37,966,552 | 17,921,219 | 20,045,333 | |
| Foreign coin | 116,121,424 | 2,274,512 | 113,846,912 | |
| | 691,248,297 | 23,891,377 | 668,587,269 | 1,230,349 |
| Excess imports over exports | | | 667,356,920 | |
| Silver: | | | | |
| Contained in domestic ore and base bullion | | 13,851 | | 13,851 |
| Contained in foreign ore and base bullion | 46,640,993 | 2,260 | 46,638,733 | |
| Domestic bullion refined | | 23,625,091 | | 23,625,091 |
| Foreign bullion refined | 7,575,122 | 21,077,634 | | 13,502,512 |
| United States coin | 2,891,952 | 864,005 | 2,027,947 | |
| Foreign coin | 6,134,604 | 5,992,558 | 142,046 | |
| | 63,242,671 | 51,575,399 | 48,808,726 | 37,141,454 |
| Excess imports over exports | | | 11,667,272 | |
| **1922.** | | | | |
| Gold: | | | | |
| Contained in domestic ore and base bullion | | 73,709 | | 73,709 |
| Contained in foreign ore and base bullion | 24,275,253 | | 24,275,253 | |
| Domestic bullion refined | 1,328,408 | 5,468,225 | | 4,139,817 |
| Foreign bullion refined | 180,365,162 | 81,799 | 180,283,363 | |
| United States coin | 4,868,558 | 30,323,172 | | 25,454,614 |
| Foreign coin | 64,332,404 | 927,989 | 63,404,415 | |
| | 275,169,785 | 36,874,894 | 267,963,031 | 29,668,140 |
| Excess imports over exports | | | 238,294,891 | |
| Silver: | | | | |
| Contained in domestic ore and base bullion | | 17,237 | | 17,237 |
| Contained in foreign ore and base bullion | 57,034,500 | | 57,034,500 | |
| Domestic bullion refined | | 25,060,886 | | 25,060,886 |
| Foreign bullion refined | 11,120,413 | 31,720,047 | | 20,599,634 |
| United States coin | 1,249,247 | 379,792 | 869,455 | |
| Foreign coin | 1,402,493 | 5,629,324 | | 4,226,831 |
| | 70,806,653 | 62,807,286 | 57,903,955 | 49,904,588 |
| Excess imports over exports | | | 7,999,367 | |

### PRICES.

Gold is valued by law at $20.67+a troy ounce. For prices of silver, see statement on page 14A.

## GRAPHITE.

### PRODUCTION.

*Domestic natural graphite sold in the United States, 1918–1922.*

| Year. | Amorphous. | | Crystalline. | |
|---|---|---|---|---|
| | Short tons. | Value. | Pounds. | Value. |
| 1918 | 6,560 | $69,455 | 12,861,839 | $1,454,799 |
| 1919 | 3,379 | 47,716 | 8,086,191 | 731,141 |
| 1920 | 4,694 | 49,758 | 9,632,360 | 576,444 |
| 1921 | 1,842 | 20,860 | 1,189,523 | 75,664 |
| 1922 | 2,200 | (a) | 1,849,766 | 85,242 |

[a] Only 2 producers, and Survey not at liberty to publish value.

Graphite is manufactured by the Acheson Graphite Co. at Niagara Falls, N. Y. The figures given below, published by permission of this company, represent only the manufactured graphite that comes into competition with natural graphite.

*Graphite manufactured by the Acheson Graphite Co., 1917–1922, in pounds.*

| | | | |
|---|---|---|---|
| 1917 | 10,474,649 | 1920 | 7,399,749 |
| 1918 | 9,182,272 | 1921 | 5,888,000 |
| 1919 | 8,163,177 | 1922 | 13,031,926 |

## IMPORTS AND EXPORTS.

*Graphite imported for consumption in the United States, 1917–1922.*

| Year. | Short tons. | Value. | Year. | Short tons. | Value. |
|---|---|---|---|---|---|
| 1917 | 42,577 | $8,961,988 | 1920 | 21,095 | $1,711,312 |
| 1918 | 19,498 | 3,092,475 | 1921 | 8,183 | 452,076 |
| 1919 | 26,626 | 2,978,096 | 1922 | 12,488 | 473,046 |

*Graphite exported from the United States, 1918–1922.*

| Year. | Unmanufactured graphite. | | Manufactures of graphite. |
|---|---|---|---|
| | Pounds. | Value. | |
| 1918 | 1,907,719 | $121,555 | $731,518 |
| 1919 | 1,258,040 | 90,185 | 788,755 |
| 1920 | 1,213,616 | 112,771 | 610,261 |
| 1921 | 1,841,578 | 95,998 | 679,359 |
| 1922 | 1,138,708 | 78,094 | [a] 255,019 |

[a] Exclusive of crucibles, figures for which are not available.

## PRICES.

*Prices of best grades of domestic flake graphite (sales at mines) and Ceylon lump (New York prices), in cents per pound, 1917–1922.*

| Year. | Domestic flake. | Ceylon lump. | Year. | Domestic flake. | Ceylon lump. |
|---|---|---|---|---|---|
| 1917 | 12–18 | 28 –32 | 1920 | 6–13 | 9 –14 |
| 1918 | 10–17¾ | 15¼–28½ | 1921 | 4–13 | 5½–6 |
| 1919 | 5–14 | 14 –15¼ | 1922 | 4– 6 | 5 –6 |

# GRINDSTONES AND PULPSTONES.

[See Abrasive materials.]

# GYPSUM.

## PRODUCTION.

*Gypsum produced and sold in the United States, 1917–1922.*

| Year. | Crude mined (short tons). | Crude and calcined sold (total value). | Year. | Crude mined (short tons). | Crude and calcined sold (total value). |
|---|---|---|---|---|---|
| 1917 | 2,696,226 | $11,116,452 | 1920 | 3,129,142 | $24,533,065 |
| 1918 | 2,057,015 | 11,470,854 | 1921 | 2,890,784 | 23,700,290 |
| 1919 | 2,420,163 | 15,727,907 | 1922 | 3,779,949 | 29,361,151 |

### IMPORTS AND EXPORTS.

Gypsum imported into the United States comes almost wholly from Nova Scotia and New Brunswick and enters the ports of New England and other North Atlantic States.

*Gypsum imported for consumption in the United States, 1918–1922.*

| Year. | Unground. | | Ground or calcined. | | Value of manufactured plaster of Paris. | Keenes cement. | | Total value. |
|---|---|---|---|---|---|---|---|---|
| | Short tons. | Value. | Short tons. | Value. | | Short tons. | Value. | |
| 1918 | 50,653 | $55,004 | 6,117 | $70,028 | $1,765 | 111 | $2,259 | $129,056 |
| 1919 | 171,733 | 211,946 | 10,415 | 126,405 | 7,719 | 187 | 5,984 | 352,054 |
| 1920 | 282,486 | 397,942 | 14,921 | 179,191 | 10,282 | 202 | 5,338 | 592,753 |
| 1921 | 266,796 | 364,318 | 4,495 | 55,109 | 33,072 | 184 | 6,836 | 459,335 |
| 1922 | 409,475 | 523,939 | 1,774 | 32,651 | 55,116 | 403 | 9,636 | 621,342 |

Exports of gypsum in 1922 were 7,673 short tons, valued at $178,166, designated as "gypsum or plaster rock, crude or ground, and plaster of Paris." Exports not separately classified for earlier years.

## ILMENITE.

[See Titanium minerals.]

## IRON ORE, PIG IRON, AND STEEL.

### IRON ORE.

[Exclusive of all domestic ore containing 5 per cent or more of manganese. For data regarding such ore, see Manganese.]

#### PRODUCTION.

*Iron ore mined in the United States in 1921 and 1922, by mining districts and varieties, in long tons.*

| District. | Hematite. | Brown ore. | Magnetite. | Carbonate. | Total. |
|---|---|---|---|---|---|
| **1921.** | | | | | |
| Lake Superior [a] | 25,298,485 | | | | 25,298,485 |
| Birmingham | 2,548,349 | 180,124 | | | 2,728,473 |
| Chattanooga | 110,096 | 54,799 | | | 164,895 |
| Adirondack | | | 446,619 | | 446,619 |
| Northern New Jersey and southeastern New York | | | 79,513 | | 79,513 |
| Other districts | [b] [c] 380,319 | [c] 135,231 | [b] 254,734 | 2,709 | 772,993 |
| | [b] [c] 28,337,249 | [c] 370,154 | [b] 780,866 | 2,709 | 29,490,978 |
| **1922.** | | | | | |
| Lake Superior [a] | 39,693,966 | | 22,050 | | 39,716,016 |
| Birmingham | 4,429,170 | 282,230 | | | 4,711,400 |
| Chattanooga | 250,083 | 122,121 | | | 372,204 |
| Adirondack | | | 406,342 | | 406,342 |
| Northern New Jersey and southeastern New York | | | 113,629 | | 113,629 |
| Other districts | [c] 515,504 | [c] 379,231 | 910,945 | 3,256 | 1,808,936 |
| | [c] 44,888,723 | [c] 783,582 | 1,452,966 | 3,256 | 47,128,527 |

[a] Includes only those mines in Wisconsin which are in the true Lake Superior district.
[b] Some magnetite included with hematite.
[c] Some hematite included with brown ore.

*Iron ore mined in the United States, 1918–1922, by varieties, in long tons.*

| Year. | Hematite. | Brown ore. | Magnetite. | Carbonate. | Total. |
|---|---|---|---|---|---|
| 1918 | 65,894,709 | 1,613,844 | 2,149,725 | | 69,658,278 |
| 1919 | [a] 57,719,582 | 1,127,397 | [a] 2,118,439 | | 60,965,418 |
| 1920 | [a] [b] 63,883,523 | [b] 1,325,661 | [a] 1,391,541 | 3,740 | 67,604,465 |
| 1921 | [a] [b] 28,337,249 | [b] 370,154 | [a] 780,866 | 2,709 | 29,490,978 |
| 1922 | [b] 44,888,723 | [b] 783,582 | 1,452,966 | 3,256 | 47,128,527 |

[a] Some magnetite included with hematite. [b] Some hematite included with brown ore.

*Iron ore mined in the Lake Superior district, 1918–1922, by ranges, in long tons.*

| Year. | Marquette. | Menominee. | Gogebic. | Vermillion. | Mesabi. | Cuyuna. | Total. |
|---|---|---|---|---|---|---|---|
| 1918 | 3,946,554 | 6,041,637 | 7,837,634 | 1,192,677 | 39,055,977 | 1,705,315 | 59,779,794 |
| 1919 | 4,158,751 | 4,863,968 | 7,368,994 | 1,051,795 | 33,262,954 | 1,685,877 | 52,392,339 |
| 1920 | 4,457,609 | 5,651,542 | 8,298,206 | 1,053,518 | 36,641,880 | 1,757,775 | 57,860,530 |
| 1921 | 2,204,114 | 2,147,569 | 3,135,477 | 981,576 | 16,380,190 | 449,559 | 25,298,485 |
| 1922 | 2,745,626 | 3,290,641 | 4,910,789 | 1,108,764 | 26,704,601 | 955,595 | 39,716,016 |

*Iron ore shipped from mines in the United States, 1921 and 1922, by States.*

[Exclusive of ore sold for paint.—See page 65A.]

| State. | 1921 | | 1922 | |
|---|---|---|---|---|
| | Long tons. | Value. | Long tons. | Value. |
| Alabama | 2,835,761 | $5,058,161 | 5,294,520 | $8,791,069 |
| California | 2,064 | 15,364 | 3,204 | 18,868 |
| Colorado | 3,823 | [a] | 513 | [a] |
| Georgia | 3,822 | 13,678 | 28,566 | 77,636 |
| Idaho | 799 | [a] | 25 | [a] |
| Maryland | 1,580 | [a] | | |
| Massachusetts | 1,262 | [a] | 4,368 | [a] |
| Michigan | 5,011,804 | 18,481,225 | 12,457,856 | 43,449,513 |
| Minnesota | 17,648,603 | 62,780,754 | 30,209,372 | 98,903,398 |
| Missouri | 36,431 | [a] | 58,320 | 244,928 |
| Montana | 26,174 | 91,729 | 21,726 | 59,566 |
| Nevada | | | 25 | [a] |
| New Jersey | 115,132 | 551,688 | 90,374 | 400,356 |
| New Mexico | 110,528 | 244,284 | 118,038 | [a] |
| New York | 174,368 | 946,366 | 191,195 | 1,049,050 |
| North Carolina | 383 | [a] | 19,279 | 49,415 |
| Pennsylvania | 187,062 | 288,955 | 782,916 | 1,022,756 |
| Tennessee | 25,219 | 68,726 | 159,473 | 418,578 |
| Texas | 131 | [a] | | |
| Utah | 60,773 | 156,865 | 15,018 | 63,806 |
| Virginia | 54,353 | 196,935 | 30,359 | 120,685 |
| Wisconsin | 117,755 | 300,954 | 794,673 | 2,455,660 |
| Wyoming | 234,701 | [a] | 332,800 | [a] |
| Undistributed | | [b] 549,624 | | [b] 684,002 |
| | 26,652,528 | 89,745,308 | 50,612,620 | 157,809,286 |

[a] Included under "Undistributed."
[b] This figure includes value for States entered as "[a]" above.

## STOCKS.

*Stocks of iron ore at mines in the United States, Dec. 31, 1921 and 1922, in long tons.*

| State. | 1921 | 1922 | State. | 1921 | 1922 |
|---|---|---|---|---|---|
| Alabama | 503,721 | 443,779 | New York | 446,879 | 683,223 |
| Georgia | 4,610 | 120 | North Carolina | 2,200 | |
| Idaho | | 175 | Pennsylvania | 8,405 | 3,069 |
| Iowa | 12,165 | 12,165 | Tennessee | 3,709 | |
| Massachusetts | 4,368 | | Virginia | 62,298 | 62,441 |
| Michigan | 7,879,344 | 6,061,403 | Wisconsin | 460,161 | 297,628 |
| Minnesota | 4,234,952 | 2,750,916 | | | |
| Missouri | 4,798 | 5,280 | | 13,836,267 | 10,524,279 |
| New Jersey | 208,657 | 204,080 | | | |

### IMPORTS AND EXPORTS.

*Iron ore imported into and exported from the United States, 1918–1922.*

| Year. | Imports. | | Exports. | |
|---|---|---|---|---|
| | Long tons. | Value. | Long tons. | Value. |
| 1918 | 787,468 | $3,464,304 | 1,256,383 | $5,535,090 |
| 1919 | 476,461 | 2,385,689 | 996,569 | 4,308,746 |
| 1920 | 1,273,456 | 4,963,654 | 1,145,037 | 6,198,927 |
| 1921 | 315,768 | 1,075,909 | 440,106 | 2,077,620 |
| 1922 | 1,135,156 | 4,916,294 | 602,194 | 2,770,878 |

### PRICES.

*Average value of iron ore per long ton at the mines in the United States, 1918–1922.*

| Year. | Hematite. | Brown ore. | Magnetite. | Carbonate. | General average. |
|---|---|---|---|---|---|
| 1918 | $3.35 | $3.51 | $4.60 | ---------- | $3.39 |
| 1919 | 3.48 | 3.63 | 4.08 | ---------- | 3.50 |
| 1920 | 4.09 | 4.19 | 4.59 | (a) | 4.11 |
| 1921 | 3.37 | 2.63 | 3.61 | (a) | 3.37 |
| 1922 | 3.14 | 2.65 | 2.37 | (a) | 3.12 |

[a] Sold for paint and not included in shipments of iron ore.

*Selling prices of iron ore per long ton at lower Lake ports at date of buying movement, 1918–1922.* [a]

| Season. | Date of buying movement. | Season iron-ore prices. | | | |
|---|---|---|---|---|---|
| | | Old range Bessemer. | Mesabi Bessemer. | Old range non-Bessemer. | Mesabi non-Bessemer. |
| 1918 | Apr. 1, 1918 | $5.95 | $5.70 | $5.20 | $5.05 |
| | July 1, 1918 | 6.40 | 6.15 | 5.65 | 5.50 |
| | Oct. 1, 1918 | 6.65 | 6.40 | 5.90 | 5.75 |
| 1919 | Apr. 28, 1919 | 6.45 | 6.20 | 5.70 | 5.55 |
| 1920 | Feb. 2, 1920 | 7.45 | 7.20 | 6.70 | 6.55 |
| 1921 | June 16, 1921 | 6.45 | 6.20 | 5.70 | 5.55 |
| 1922 | June 9, 1922 | 5.95 | 5.70 | 5.20 | 5.05 |

[a] Iron Trade Review.

## PIG IRON.

### PRODUCTION.

*Pig iron shipped from blast furnaces in the United States in 1921 and 1922, by States.*

| State. | 1921 | | 1922 | |
|---|---|---|---|---|
| | Long tons. | Value. | Long tons. | Value. |
| Alabama | 1,241,227 | $30,195,978 | 2,223,159 | $42,883,424 |
| Illinois | 1,490,638 | 36,513,263 | 2,729,172 | 58,954,675 |
| Indiana | 1,655,275 | 36,945,411 | 2,191,356 | 43,064,817 |
| Kentucky | 28,375 | 816,372 | 140,217 | 2,951,627 |
| Michigan | 200,944 | 5,955,205 | 595,647 | 14,791,041 |
| Missouri | 17,028 | 479,957 | (a) | (a) |
| New York | 786,713 | 18,212,810 | 1,708,605 | 37,783,073 |
| Ohio | 3,649,835 | 88,473,082 | 6,756,648 | 149,805,909 |
| Pennsylvania | 6,072,196 | 148,350,285 | 9,732,024 | 221,581,288 |
| Tennessee | 21,972 | 595,850 | 95,326 | 2,063,376 |
| Virginia | 66,916 | 2,023,268 | 31,022 | 793,903 |
| West Virginia | 259,312 | 6,557,498 | 309,944 | 7,537,184 |
| Wisconsin | 93,666 | 2,730,155 | 209,289 | 4,970,227 |
| Other States[b] | 454,522 | 11,588,658 | 948,329 | 20,964,314 |
| | 16,038,619 | 389,437,792 | 27,670,738 | 608,144,858 |

[a] Included under "Other States."
[b] 1921: Colorado, Connecticut, Maryland, Massachusetts, Minnesota, and New Jersey; 1922: Same States as in 1921, with Missouri in addition.

*Pig iron shipped from blast furnaces in the United States, 1917–1922.*

| Year. | Long tons. | Value. | Year. | Long tons. | Value. |
|---|---|---|---|---|---|
| 1917 | 38,612,546 | $1,053,785,975 | 1920 | 35,710,227 | $1,140,904,096 |
| 1918 | 38,230,440 | 1,180,759,565 | 1921 | 16,038,619 | 389,437,792 |
| 1919 | 30,130,231 | 775,915,043 | 1922 | 27,670,738 | 608,144,858 |

## IMPORTS AND EXPORTS.

*Pig iron, including kentledge, ferromanganese, ferrosilicon, and spiegeleisen, imported into the United States, 1917–1922.*

| Year. | Long tons. | Value. | Year. | Long tons. | Value. |
|---|---|---|---|---|---|
| 1917 | 76,786 | $7,872,105 | 1920 | 185,944 | $12,801,834 |
| 1918 | 34,711 | 4,968,056 | 1921 | 44,036 | 2,014,926 |
| 1919 | 101,665 | 6,565,106 | 1922 | 492,596 | 15,596,743 |

*Pig iron (including ferroalloys) exported from the United States, 1917–1922.*

| Year. | Long tons. | Value. | Year. | Long tons. | Value. |
|---|---|---|---|---|---|
| 1917 | 656,220 | $24,037,051 | 1920 | 216,828 | $10,074,377 |
| 1918 | 269,575 | 11,576,721 | 1921 | 28,307 | 933,093 |
| 1919 | 321,261 | 12,313,183 | 1922 | 33,005 | 872,343 |

## PRICES.

*Average monthly prices per ton of principal grades of pig iron in the United States, 1921 and 1922.*[a]

| Month. | Foundry pig iron at Valley furnaces. | | Foundry pig iron at Birmingham furnaces. | | Bessemer pig iron at Valley furnaces. | | Basic pig iron at Valley furnaces. | |
|---|---|---|---|---|---|---|---|---|
| | 1921 | 1922 | 1921 | 1922 | 1921 | 1922 | 1921 | 1922 |
| January | $31.92 | $19.38 | $31.14 | $15.96 | $32.00 | $19.62 | $30.00 | $18.19 |
| February | 28.29 | 18.92 | 27.50 | 15.33 | 29.63 | 19.40 | 27.71 | 18.00 |
| March | 25.89 | 18.87 | 25.52 | 15.31 | 26.70 | 19.02 | 24.41 | 17.89 |
| April | 24.81 | 20.74 | 23.77 | 15.74 | 25.00 | 20.88 | 23.00 | 19.98 |
| May | 23.60 | 24.00 | 21.80 | 17.63 | 24.32 | 25.08 | 22.15 | 24.62 |
| June | 22.42 | 24.00 | 20.48 | 18.44 | 22.88 | 25.00 | 21.20 | 25.00 |
| July | 20.40 | 24.20 | 20.18 | 18.56 | 21.34 | 25.00 | 19.52 | 24.32 |
| August | 19.59 | 29.04 | 18.70 | 20.37 | 20.00 | 27.74 | 18.22 | 26.17 |
| September | 20.86 | 35.02 | 19.06 | 25.40 | 20.00 | 33.76 | 19.00 | 30.08 |
| October | 21.00 | 31.63 | 19.00 | 27.04 | 20.00 | 33.23 | 19.24 | 30.23 |
| November | 20.78 | 28.78 | 18.56 | 24.12 | 20.00 | 31.70 | 19.00 | 28.28 |
| December | 20.00 | 25.92 | 17.31 | 22.70 | 20.00 | 27.78 | 19.00 | 24.96 |
| Average | 23.30 | 25.04 | 21.92 | 19.72 | 23.49 | 25.68 | 21.87 | 23.98 |

[a] Metal Statistics, 1923.

## STEEL.

*Steel produced in the United States, 1918–1922, in long tons.*[a]

| Year. | Bessemer. | Open-hearth. | Crucible. | Other steel. | Total. |
|---|---|---|---|---|---|
| 1918 | 9,376,236 | 34,459,391 | 115,112 | 511,693 | 44,462,432 |
| 1919 | 7,271,562 | 26,948,694 | 63,572 | 387,404 | 34,671,232 |
| 1920 | 8,883,087 | 32,671,895 | 72,265 | 505,687 | 42,132,934 |
| 1921 | 4,015,938 | 15,589,802 | 7,613 | 170,444 | 19,783,797 |
| 1922 | 5,919,298 | 29,308,983 | 28,606 | 346,039 | 35,602,926 |

[a] According to the American Iron and Steel Institute.

## LEAD.

### SUPPLY.

*Apparent consumption of refined primary lead in the United States (refinery stocks disregarded), 1918–1922, in short tons.*

| | 1918 | 1919 | 1920 | 1921 | 1922 |
|---|---|---|---|---|---|
| Supply: | | | | | |
| Stock in bonded warehouses Jan. 1 | 2,685 | 472 | 234 | 1,322 | 347 |
| Imports of pigs, bars, and old | 5,240 | 5,107 | 35,719 | 31,301 | 3,551 |
| Production | 640,195 | 482,220 | 529,657 | 448,589 | 532,662 |
| | 648,120 | 487,799 | 565,610 | 481,212 | 536,560 |
| Withdrawn: | | | | | |
| Exports of foreign lead— | | | | | |
| From warehouse | 59,416 | 40,976 | 17,363 | 25,000 | 32,355 |
| In manufactures, with benefit of drawback | 3,426 | 1,936 | 6,175 | 9,369 | 5,677 |
| Exports of domestic lead | 41,831 | 10,510 | 2,730 | 1,624 | 5,823 |
| Stock in bonded warehouses Dec. 31 | 472 | 234 | 1,322 | 347 | (a) |
| | 105,145 | 53,656 | 27,590 | 36,340 | 43,855 |
| Apparent consumption | 542,975 | 434,143 | 538,020 | 444,872 | 492,705 |

[a] Figures not available.

### PRODUCTION.

*Refined primary lead produced in the United States, 1918–1922, in short tons.*

| | 1918 | 1919 | 1920 | 1921 | 1922 |
|---|---|---|---|---|---|
| Domestic ore: | | | | | |
| Desilverized lead | 282,024 | 208,751 | 220,327 | 187,962 | 185,191 |
| Soft lead | 210,463 | 147,744 | 189,854 | 157,513 | 209,250 |
| Desilverized soft lead | 47,418 | 67,938 | 66,668 | 52,747 | 74,305 |
| Total from domestic ore | 539,905 | 424,433 | 476,849 | 398,222 | 468,746 |
| Foreign ore: | | | | | |
| Africa | 1,519 | 644 | 1,171 | ---------- | ---------- |
| Australia | 282 | 69 | 450 | ---------- | ---------- |
| Canada | 7,550 | 1,895 | 1,186 | 2,877 | 3,604 |
| Central America | ---------- | 12 | 22 | 6 | 14 |
| Mexico | 4,798 | 2,261 | 2,729 | 1,912 | 7,260 |
| South America | 1,101 | 2,537 | 2,747 | 2,235 | 2,458 |
| Other foreign | 84 | 238 | 109 | 90 | 562 |
| Foreign base bullion: | | | | | |
| Canada | 8,108 | 567 | 1,919 | 1,599 | 2,900 |
| Mexico | 76,809 | 49,564 | 42,421 | 41,648 | 47,118 |
| South America | 39 | ---------- | 54 | ---------- | ---------- |
| Total from foreign ore and base bullion | 100,290 | 57,787 | 52,808 | 50,367 | 63,916 |
| Grand total from all sources | 640,195 | 482,220 | 529,657 | 448,589 | 532,662 |
| Production of antimonial lead | 18,570 | 13,874 | 12,535 | 10,064 | 8,075 |

*Refined primary lead produced in the United States from domestic ores, 1917–1922.*

| Year. | Short tons. | Value. | Year. | Short tons. | Value. |
|---|---|---|---|---|---|
| 1917 | 548,450 | $94,333,000 | 1920 | 476,849 | $76,296,000 |
| 1918 | 539,905 | 76,667,000 | 1921 | 398,222 | 35,840,000 |
| 1919 | 424,433 | 44,990,000 | 1922 | 468,746 | 51,562,000 |

*Secondary lead recovered in the United States, 1918–1922, in short tons.*

| | 1918 | 1919 | 1920 | 1921 | 1922 |
|---|---|---|---|---|---|
| Pig lead | 41,146 | 55,684 | 56,350 | 46,370 | 75,480 |
| Lead in alloys | 55,954 | 66,416 | 68,300 | 57,410 | 84,080 |
| Total recovered lead | 97,100 | 122,100 | 124,650 | 103,780 | 159,560 |

## IMPORTS AND EXPORTS.

*Lead imported into the United States in ore, base bullion, and refined, by sources, 1918–1922, in pounds.*

[General imports.]

| Year. | Canada. | Mexico. | South America. | Europe. | Other countries. | Total imports. |
|---|---|---|---|---|---|---|
| 1918 | 28,225,878 | 162,259,199 | 1,962,124 | 62,510 | 4,705,049 | 197,214,760 |
| 1919 | 10,391,115 | 125,541,614 | 5,504,416 | 89,840 | 286,142 | 141,813,127 |
| 1920 | 8,199,234 | 131,815,278 | 7,085,351 | 38,766,504 | 11,163,160 | 197,029,527 |
| 1921 | 8,127,158 | 106,406,238 | 2,381,365 | 30,224,701 | 1,430,949 | 148,570,411 |
| 1922 | 8,663,236 | 141,216,136 | 3,803,478 | 1,454,384 | 513,335 | 155,650,569 |

*Lead imported into the United States, by classes, 1918–1922, in pounds.*

[General imports.]

| Year. | Lead in ore (lead content). | Base bullion. | | Pigs, bars, sheets, and old. | Total lead content. |
|---|---|---|---|---|---|
| | | Gross weight. | Lead content. | | |
| 1918 | 37,070,340 | 155,810,003 | 149,663,889 | 10,480,531 | 197,214,760 |
| 1919 | 19,573,856 | 115,317,160 | 112,024,518 | 10,214,753 | 141,813,127 |
| 1920 | 29,488,816 | 101,476,550 | 96,103,603 | 71,437,108 | 197,029,527 |
| 1921 | 14,234,039 | 77,882,834 | 71,733,838 | 62,602,534 | 148,570,411 |
| 1922 | 24,474,481 | [a] | 124,074,465 | 7,101,623 | 155,650,569 |

[a] Figures not available.

*Lead imported for consumption in the United States, 1918–1922, by classes.*

| Year. | Lead in ore.[a] | | Base bullion. | | Pigs, bars, and old.[b] | | Sheets, pipe, and shot. | | Not otherwise specified (value). | Total value. |
|---|---|---|---|---|---|---|---|---|---|---|
| | Pounds. | Value. | Pounds. | Value. | Pounds. | Value. | Pounds. | Value. | | |
| 1918 | 6,064,902 | $344,080 | 3,559,071 | $180,070 | 1,139,950 | $56,694 | 6,892 | $624 | $36,723 | $618,191 |
| 1919 | 4,106,823 | 196,363 | 31,796,693 | 1,130,937 | 10,174,115 | 415,094 | 8,018 | 628 | 17,187 | 1,760,209 |
| 1920 | 13,700,499 | 908,619 | 66,816,820 | 3,340,600 | 68,901,959 | 3,887,821 | 81,396 | 5,483 | 21,328 | 8,163,851 |
| 1921 | 6,842,807 | 327,046 | 56,819,980 | 1,668,410 | 61,909,094 | 1,972,716 | 3,087 | 140 | 11,204 | 3,979,516 |
| 1922 | 23,649,851 | 812,603 | 55,859,422 | 1,815,142 | 8,563,110 | 335,924 | 6,018 | 697 | 12,286 | 2,976,652 |

[a] Includes also lead in matte beginning Sept. 22, 1922, when new tariff went into effect.
[b] Includes also imports of antimonial lead, antimonial scrap lead, babbitt metal, solder, etc., beginning Sept. 22, 1922, when new tariff went into effect.

*Lead exported from the United States, 1918–1922, by classes.*

| Year. | Pigs and bars. | | | | Foreign lead used in articles exported with benefit of drawback.[a] | | Manufactures of lead from both domestic and foreign ores. |
|---|---|---|---|---|---|---|---|
| | From domestic ore. | | From foreign ore. | | | | |
| | Pounds. | Value. | Pounds. | Value. | Pounds. | Value. | |
| 1918 | 83,662,322 | $5,889,381 | 118,832,344 | $8,309,798 | 6,852,173 | $350,851 | $1,828,473 |
| 1919 | 21,019,605 | 1,471,256 | 81,951,396 | 4,536,273 | 3,872,130 | 207,087 | 2,155,436 |
| 1920 | 5,459,713 | 462,223 | 34,725,501 | 2,570,535 | 12,350,794 | 536,322 | 3,621,397 |
| 1921 | 3,247,294 | 177,926 | 50,000,259 | 2,284,107 | 18,738,927 | [b] | 1,376,259 |
| 1922 | 11,645,821 | 604,605 | 64,709,305 | 3,177,360 | 11,354,070 | [b] | 1,158,150 |

[a] Exclusive of lead that entered as pig and was exported in the same form, which would be duplicated in exports of lead from foreign ore.
[b] Figures not available.

*Pig lead exported from the United States, 1920–1922, by destinations, in short tons.*

| Destination. | 1920 | | 1921 | | 1922 | |
|---|---|---|---|---|---|---|
| | Domestic. | Foreign. | Domestic. | Foreign. | Domestic. | Foreign. |
| Canada | 364 | 1,357 | 170 | 40 | 337 | 150 |
| Great Britain | 252 | 2,439 | 3 | 13,154 | 1,374 | 8,281 |
| Netherlands | 146 | 1,871 | 118 | 1,401 | 1 | 1,681 |
| France | 23 | 1,008 | 616 | 224 | 1,737 | 10,678 |
| Japan | 392 | 3,584 | 28 | 4,200 | 246 | 56 |
| Other countries | 1,553 | 7,104 | 689 | 5,981 | 2,128 | 11,509 |
| | 2,730 | 17,363 | 1,624 | 25,000 | 5,823 | 32,355 |

## PRICES.

[See statement on page 14A.]

## LIME.

### PRODUCTION.

*Lime, produced in the United States, sold in 1918–1922.*

| Year. | Short tons. | Value.[a] | Number of plants in operation. |
|---|---|---|---|
| 1918 | 3,206,016 | $26,808,909 | 496 |
| 1919 | 3,330,347 | 29,448,553 | 539 |
| 1920 | 3,570,141 | 37,543,840 | 515 |
| 1921 | 2,532,153 | 24,895,370 | 520 |
| 1922 | 3,639,617 | 33,255,039 | 530 |

[a] The value given represents the value of bulk lime f. o. b. at point of shipment and does not include cost of barrel or package.

*Hydrated lime, produced in the United States, sold in 1918–1922.*

| Year. | Short tons. | Value | Number of plants in operation. |
|---|---|---|---|
| 1918 | 620,216 | $5,342,113 | 90 |
| 1919 | 777,408 | 7,061,146 | 93 |
| 1920 | 853,116 | 9,287,562 | 98 |
| 1921 | 792,970 | 7,421,637 | 105 |
| 1922 | 1,106,063 | 9,868,980 | 114 |

*Lime sold in the United States in 1921 and 1922, by States.*

| State. | 1921 | | | 1922 | | |
|---|---|---|---|---|---|---|
| | Number of plants in operation. | Short tons. | Value. | Number of plants in operation. | Short tons. | Value. |
| Alabama | 10 | 109,256 | $847,629 | 11 | 168,135 | $979,331 |
| Arizona | 3 | 11,783 | 162,647 | 2 | (a) | (a) |
| Arkansas | 3 | 8,958 | 93,499 | 5 | 11,951 | 115,008 |
| California | 7 | 42,115 | 577,366 | 8 | 55,161 | 683,774 |
| Colorado | 3 | 5,783 | 56,956 | 4 | (a) | (a) |
| Connecticut | 5 | (a) | (a) | 6 | 52,108 | 743,742 |
| Florida | 2 | (a) | (a) | 3 | (a) | (a) |
| Georgia | 1 | (a) | (a) | 1 | (a) | (a) |
| Hawaii | 1 | 1,985 | 50,690 | 1 | (a) | (a) |
| Idaho | 1 | (a) | (a) | 2 | (a) | (a) |
| Illinois | 12 | 58,222 | 610,197 | 10 | 85,425 | 860,945 |
| Indiana | 8 | 90,542 | 826,311 | 8 | 113,246 | 938,645 |
| Iowa | 2 | (a) | (a) | 2 | (a) | (a) |
| Kentucky | 3 | 1,524 | 11,551 | 3 | 1,560 | 11,062 |
| Maine | 4 | 90,585 | 1,392,850 | 4 | 127,840 | 1,757,480 |
| Maryland | 17 | 64,835 | 558,785 | 21 | 71,261 | 554,194 |
| Massachusetts | 10 | 124,183 | 1,890,512 | 10 | 164,980 | 2,510,368 |
| Michigan | 6 | 48,164 | 445,386 | 7 | 53,635 | 484,945 |
| Minnesota | 5 | 22,109 | 232,037 | 5 | 27,670 | 307,270 |
| Missouri | 17 | 159,194 | 1,656,560 | 16 | 203,984 | 1,953,524 |
| Montana | 2 | (a) | (a) | 2 | (a) | (a) |
| Nevada | 1 | (a) | (a) | 1 | (a) | (a) |
| New Jersey | 7 | 1,818 | 14,365 | 4 | 2,392 | 20,845 |
| New Mexico | 4 | 3,044 | 33,660 | 4 | 3,587 | 38,520 |
| New York | 16 | 67,685 | 759,299 | 16 | 96,320 | 957,079 |
| North Carolina | 1 | (a) | (a) | 1 | (a) | (a) |
| Ohio | 31 | 471,053 | 4,224,579 | 29 | 752,916 | 6,495,066 |
| Oklahoma | 2 | (a) | (a) | 2 | (a) | (a) |
| Oregon | 1 | (a) | (a) | 2 | (a) | (a) |
| Pennsylvania | 183 | 509,891 | 4,247,509 | 177 | 719,536 | 5,581,794 |
| Porto Rico | 23 | 2,740 | 44,113 | 27 | 5,822 | 67,636 |
| Rhode Island | 1 | (a) | (a) | 1 | (a) | (a) |
| South Dakota | 2 | (a) | (a) | 3 | 3,852 | 43,990 |
| Tennessee | 17 | 93,397 | 733,639 | 15 | 126,305 | 939,039 |
| Texas | 8 | 44,404 | 452,078 | 7 | 52,552 | 524,985 |
| Utah | 10 | 7,972 | 104,605 | 13 | 11,082 | 147,087 |
| Vermont | 9 | 32,782 | 460,318 | 9 | 44,745 | 565,498 |
| Virginia | 36 | 111,518 | 1,005,677 | 41 | 152,436 | 1,251,683 |
| Washington | 7 | 17,710 | 209,761 | 6 | 25,447 | 355,412 |
| West Virginia | 13 | 119,716 | 1,015,690 | 15 | 219,146 | 1,643,055 |
| Wisconsin | 24 | 124,078 | 999,407 | 24 | 189,558 | 1,589,931 |
| Wyoming | 2 | (a) | (a) | 2 | (a) | (a) |
| Undistributed | | 85,107 | 1,177,694 | | 96,965 | 1,133,131 |
| | 520 | 2,532,153 | 24,895,370 | 530 | 3,639,617 | 33,255,039 |

a Included under "Undistributed."

## IMPORTS AND EXPORTS.

*Lime imported for consumption in the United States, 1917–1922.*

| Year. | Short tons. | Value. | Year. | Short tons. | Value. |
|---|---|---|---|---|---|
| 1917 | 7,353 | $70,505 | 1920 | 22,688 | $392,137 |
| 1918 | 6,650 | 73,458 | 1921 | 10,811 | 234,798 |
| 1919 | 8,679 | 128,519 | 1922 | 14,112 | 290,845 |

*Lime exported from the United States, 1917–1922.*

| Year. | Short tons. | Value. | Year. | Short tons. | Value. |
|---|---|---|---|---|---|
| 1917 | 18,794 | $168,671 | 1920 | 5,921 | $128,296 |
| 1918 | 7,191 | 105,803 | 1921 | 5,192 | 109,769 |
| 1919 | 6,372 | 108,370 | 1922 | 8,289 | 116,649 |

## LITHIUM MINERALS.

### PRODUCTION.

*Lithium minerals produced in the United States, 1917–1922.*

| Year. | Short tons. | Value. | Year. | Short tons. | Value. |
|---|---|---|---|---|---|
| 1917 | 2,062 | $42,912 | 1920 | 11,696 | $173,002 |
| 1918 | 5,894 | 111,600 | 1921 | 1,833 | 33,508 |
| 1919 | 6,287 | 115,000 | 1922 | 2,192 | 41,300 |

### IMPORTS AND EXPORTS.

Imports and exports of lithium minerals are not reported separately.

## LITHOGRAPHIC STONE.

### PRODUCTION.

During 1913 and 1914 small quantities of lithographic stone were quarried at Brandenburg, Meade County, Ky. No domestic production was reported for 1915 nor has any been reported since 1918.

*Lithographic stone produced in the United States, 1916–1918.*

| Year. | Pounds. | Value. | Year. | Pounds. | Value. |
|---|---|---|---|---|---|
| 1916 | 40,000 | $1,500 | 1918 | 6,000 | $350 |
| 1917 | 5,832 | 489 | | | |

### IMPORTS AND EXPORTS.

*Lithographic stone imported for consumption in the United States, 1917–1922.*

| Year. | Pounds. | Value. | Year. | Pounds. | Value. |
|---|---|---|---|---|---|
| 1917 | | | 1920 | 786,119 | $63,733 |
| 1918 | | | 1921 | 301,546 | 34,101 |
| 1919 | 464,914 | $216,293 | 1922 | 256,426 | 28,242 |

No exports of lithographic stone are reported.

## MAGNESITE.

### PRODUCTION.

*Crude domestic magnesite sold or treated in the United States, 1918–1922.*

| Year. | California. | | Washington. | | Total. | |
|---|---|---|---|---|---|---|
| | Short tons. | Value. | Short tons. | Value. | Short tons. | Value. |
| 1918 | 84,077 | $761,811 | 147,528 | $1,050,790 | 231,605 | $1,812,601 |
| 1919 | 50,020 | 504,973 | 106,206 | 743,442 | 156,226 | 1,248,415 |
| 1920 | 81,782 | 1,083,262 | 221,985 | 1,664,888 | 303,767 | 2,748,150 |
| 1921 | 47,904 | 510,177 | | | 47,904 | 510,177 |
| 1922 | [a] 55,790 | [a] 571,745 | [a] | [a] | 55,790 | 571,745 |

[a] Washington included with California. Survey not at liberty to publish figures.

### IMPORTS AND EXPORTS.

*Magnesite imported for consumption in the United States, 1918–1922.*

| Year. | Crude. | | Calcined, not purified. | |
|---|---|---|---|---|
| | Short tons. | Value. | Short tons. | Value. |
| 1918 | 5,432 | $103,233 | 19,049 | $824,022 |
| 1919 | 6,381 | 103,311 | 9,471 | 270,721 |
| 1920 | 33,550 | 406,204 | 14,780 | 373,165 |
| 1921 | 51,993 | 525,452 | 6,788 | 250,932 |
| 1922 | 73,331 | 976,283 | 72,265 | 1,267,622 |

Exports are not separately recorded.

## MAGNESIUM.

### PRODUCTION.

*Domestic metallic magnesium sold or used in the United States, 1918–1922.*

| Year. | Number of producers. | Pounds. | Value. | Average price per pound. | |
|---|---|---|---|---|---|
| | | | | Ingot (stick). | Powder. |
| 1918 | 4 | 284,118 | $615,217 | $1.81 | $2.67 |
| 1919 | 3 | 127,465 | 247,302 | 1.83 | 2.85 |
| 1920 | 2 | (a) | (a) | 1.60 | 2.75 |
| 1921 | 1 | 48,000 | 86,000 | 1.30 | 2.36 |
| 1922 | 2 | b 60,000 | b 89,000 | 1.60 | 1.13 |

[a] Survey not at liberty to publish figures.
[b] Estimate.

### IMPORTS AND EXPORTS.

*Magnesium imported for consumption in the United States, 1918–1922.*

| Year. | Pounds. | Value. |
|---|---|---|
| 1918 (July to December) [a] | 11,899 | $16,259 |
| 1919 | 13,239 | 13,583 |
| 1920 | 29,275 | 25,055 |
| 1921 | 39,913 | 30,592 |
| 1922 | 182,939 | 54,448 |

[a] Prior to 1915 the entire domestic supply was imported, but such imports are not separately shown until July, 1918.

Exports are not separately recorded.

10253°—25†——5

## MANGANESE.

### SUPPLY.

*Manganese alloys and ore produced in the United States and imported from principal foreign sources, 1918–1922, in long tons.*

| Year. | Steel. | Ferromanganese. | | Spiegeleisen. | | Manganese ore. | | | | |
|---|---|---|---|---|---|---|---|---|---|---|
| | Production.[a] | Shipments. | Imports. | Shipments. | Imports. | Shipments.[b] | Total imports. | Imports from— | | |
| | | | | | | | | Russia. | India. | Brazil. |
| 1918 | 44,462,432 | 306,076 | 27,168 | 263,861 | 1,969 | 305,869 | 491,303 | ..... | 29,275 | 345,877 |
| 1919 | 34,671,232 | 198,255 | 33,022 | 90,855 | 27 | 54,957 | 333,344 | 6,916 | 9,200 | 246,592 |
| 1920 | 42,132,934 | 276,594 | 59,254 | 103,672 | 5,234 | 94,420 | [c]599,764 | 18,762 | 71,238 | 421,523 |
| 1921 | 19,783,797 | 111,374 | 9,077 | 69,230 | 307 | 13,531 | [c]392,666 | ..... | 113,730 | 262,468 |
| 1922 | 35,602,926 | 161,612 | 95,007 | 70,253 | 8,151 | 13,404 | 374,451 | [d]1,642 | 24,548 | 275,193 |

[a] According to American Iron and Steel Institute.
[b] Exclusive of small quantities of ore shipped for fluxing purposes. See second table following.
[c] Exclusive of 7,173 tons in 1920 and 8,748 tons in 1921 reported by Bureau of Foreign and Domestic Commerce as manganese ore. The value of this "ore" ranged from $46 to $292 a ton, consequently the Survey believes that the figures represent imports of ferromanganese, spiegeleisen, manganese chemicals, and perhaps some chemical ore.
[d] Imports from Ukraine.

### PRODUCTION.

*Manganese and manganiferous ore (exclusive of fluxing ore) shipped from mines in the United States in 1921–1922, by States.*

| State. | Ore containing 35 per cent of manganese or more. | | | Ore containing 10 to 35 per cent of manganese. | | | Ore containing 5 to 10 per cent of manganese. | | |
|---|---|---|---|---|---|---|---|---|---|
| | Number of shippers. | Long tons. | Value. | Number of shippers. | Long tons. | Value. | Number of shippers. | Long tons. | Value. |
| 1921. | | | | | | | | | |
| Arizona | 2 | 328 | [a] | ..... | ..... | ..... | ..... | ..... | ..... |
| Arkansas | 3 | 728 | $16,360 | 2 | 278 | $3,683 | ..... | ..... | ..... |
| Colorado | 1 | 490 | [a] | 1 | 924 | [a] | ..... | ..... | ..... |
| Georgia | ..... | ..... | ..... | 1 | 7,162 | [a] | 1 | 6,140 | [a] |
| Michigan | ..... | ..... | ..... | 1 | 51 | [a] | ..... | ..... | ..... |
| Minnesota | ..... | ..... | ..... | ..... | ..... | ..... | 2 | 56,530 | [a] |
| Montana | 3 | 11,129 | 444,981 | ..... | ..... | ..... | ..... | ..... | ..... |
| Tennessee | 1 | 139 | 3,396 | 1 | 24 | 257 | ..... | ..... | ..... |
| Virginia | 4 | 717 | 15,549 | ..... | ..... | ..... | ..... | ..... | ..... |
| Undistributed | ..... | ..... | 14,811 | ..... | ..... | 38,815 | ..... | ..... | $147,576 |
| | 14 | 13,531 | 495,097 | 6 | 8,439 | 42,755 | 3 | 62,670 | 147,576 |
| 1922. | | | | | | | | | |
| Alabama | ..... | ..... | ..... | 1 | 475 | 1,900 | ..... | ..... | ..... |
| Arizona | 2 | 203 | 2,572 | ..... | ..... | ..... | ..... | ..... | ..... |
| Arkansas | 9 | 2,264 | 42,197 | ..... | ..... | ..... | ..... | ..... | ..... |
| California | 1 | [a] | [a] | ..... | ..... | ..... | ..... | ..... | ..... |
| Georgia | ..... | ..... | ..... | 1 | 839 | [a] | 1 | 194 | [a] |
| Michigan | ..... | ..... | ..... | 2 | 9,644 | [a] | ..... | ..... | ..... |
| Minnesota | ..... | ..... | ..... | 3 | 305,093 | 940,311 | 4 | 248,560 | 622,278 |
| Montana | 3 | 9,751 | 371,245 | ..... | ..... | ..... | ..... | ..... | ..... |
| Nevada | 1 | [a] | [a] | ..... | ..... | ..... | ..... | ..... | ..... |
| New Mexico | ..... | ..... | ..... | 2 | 28,623 | [a] | ..... | ..... | ..... |
| Tennessee | 1 | 113 | 1,636 | ..... | ..... | ..... | ..... | ..... | ..... |
| Virginia | 1 | 809 | [a] | ..... | ..... | ..... | ..... | ..... | ..... |
| Wisconsin | ..... | ..... | ..... | ..... | ..... | ..... | 1 | 2,860 | [a] |
| Undistributed | ..... | 273 | 37,510 | ..... | ..... | 129,569 | ..... | ..... | 9,761 |
| | 18 | 13,404 | 455,160 | 9 | 344,674 | 1,071,780 | 6 | 251,614 | 632,039 |
| Total, 1920 | 56 | 94,420 | 2,396,235 | 31 | 357,279 | 1,450,518 | 6 | 279,687 | 644,572 |
| Total, 1919 | 42 | 54,957 | 1,791,118 | 24 | 211,632 | 965,660 | 9 | 112,303 | 352,570 |

[a] Included under "Undistributed." Geological Survey not at liberty to publish.

*Manganese and manganiferous ore (for fluxing purposes) shipped from mines in the United States, 1918–1922.*

| Year. | Ore containing 35 per cent of manganese or more. | | Ore containing 10 to 35 per cent of manganese. | | Ore containing 5 to 10 per cent of manganese.[a] | |
|---|---|---|---|---|---|---|
| | Long tons. | Value. | Long tons. | Value. | Long tons. | Value. |
| 1918 | | | 98,160 | $158,785 | 18,196 | $54,671 |
| 1919 | 365 | $5,745 | 98,202 | 216,868 | 11,596 | 17,394 |
| 1920 | | | 123,970 | 332,615 | 6,728 | 10,093 |
| 1921 | | | 22,962 | [b]57,000 | 3,028 | [b]7,809 |
| 1922 | 2,278 | 17,341 | 27,705 | [b]52,000 | 1,666 | [b]10,699 |

[a] Includes small quantities of ore containing less than 5 per cent of manganese. For such figures see p. 588.
[b] Estimated.

*Manganiferous silver ore shipped from mines in the United States, 1918–1922, in long tons.*

| Year. | Arizona. | Colorado. | Montana. | Nevada. | New Mexico. |
|---|---|---|---|---|---|
| 1918 | 10,854 | 124,041 | | 80,096 | 475 |
| 1919 | 1,964 | 40,824 | | 77,815 | 250 |
| 1920 | 345 | 45,726 | | 95,142 | 541 |
| 1921 | | 11,743 | | 14,871 | 300 |
| 1922 | | 13,951 | 6,656 | | 8,764 |

*Manganiferous iron ore shipped from the Cuyuna district, Minn., 1917–1922, in long tons.*

| Year. | Ore containing 10 to 35 per cent of manganese. | Ore containing 5 to 10 per cent of manganese. | Year. | Ore containing 10 to 35 per cent of manganese. | Ore containing 5 to 10 per cent of manganese. |
|---|---|---|---|---|---|
| 1917 | 359,542 | 91,590 | 1920 | 293,524 | 248,913 |
| 1918 | 625,009 | 227,202 | 1921 | | 56,530 |
| 1919 | 138,952 | 98,220 | 1922 | 305,093 | 248,560 |

## MANGANIFEROUS ZINC RESIDUUM.

Manganiferous zinc residuum containing 12 to 15 per cent of manganese and 40 per cent of iron is recovered from roasted franklinite concentrates at Franklin Furnace, N. J. No price is given for this material, as it is not sold in the open market, but is reduced to spiegeleisen by the company that produces it.

*Manganiferous residuum, from zinc roasting in the United States, shipped in 1917–1922, in long tons.*

| | | | |
|---|---|---|---|
| 1917 | 155,332 | 1920 | 133,602 |
| 1918 | 146,796 | 1921 | 12,627 |
| 1919 | 80,418 | 1922 | 81,333 |

## MARL.

*Calcareous marl, produced in the United States, sold in 1917–1922.*

| Year. | Short tons. | Value. | Year. | Short tons. | Value. |
|---|---|---|---|---|---|
| 1917 | 73,900 | $165,223 | 1920 | 97,487 | $322,339 |
| 1918 | 98,694 | 261,082 | 1921 | 59,730 | 195,743 |
| 1919 | 91,437 | 327,294 | 1922 | 67,777 | 203,196 |

Greensand marl is produced in New Jersey. The quantity mined in 1922 was 7,885 short tons, valued at $56,800, compared with 2,058 tons, valued at $10,200, in 1921.

No imports or exports of marl are reported.

## MICA.

### PRODUCTION.

*Domestic mica sold in the United States, 1918–1922.*

| Year. | Sheet mica. | | Scrap mica. | | Total. | |
|---|---|---|---|---|---|---|
| | Pounds. | Value. | Short tons. | Value. | Short tons. | Value. |
| 1918 | 1,644,200 | $731,810 | 2,292 | $33,130 | 3,114 | $764,940 |
| 1919 | 1,545,709 | 483,567 | 3,258 | 58,084 | 4,031 | 541,651 |
| 1920 | [a]1,683,480 | [a]546,972 | 5,723 | 167,017 | [a]6,565 | [a]713,989 |
| 1921 | [a]741,845 | [a]118,513 | 2,577 | 56,849 | [a]2,948 | [a]175,362 |
| 1922 | [a]1,077,968 | [a]194,301 | 6,641 | 114,045 | [a]7,180 | [a]308,346 |

[a] The figures for sheet mica in 1920–1922 are not strictly comparable with those for earlier years, as they represent uncut sheet mica exclusively. Prior to 1920 some cut sheet mica was included—the cutting having the two-fold effect of reducing the quantity and of increasing the value.

### IMPORTS AND EXPORTS.

*Mica imported for consumption in the United States, 1918–1922.*

| Year. | Sheet. | | | | Ground. | | Total. | |
|---|---|---|---|---|---|---|---|---|
| | Unmanufactured. | | Cut and splittings. | | | | | |
| | Pounds. | Value. | Pounds. | Value. | Pounds. | Value. | Pounds. | Value. |
| 1918 | 741,429 | $658,576 | [a] | $880,906 | 11,587 | $1,647 | [a] | $1,541,129 |
| 1919 | 723,713 | 726,532 | [a] | 762,228 | 62 | 9 | [a] | 1,488,769 |
| 1920 | 1,298,537 | 1,177,943 | [a] | 2,011,434 | | | [a] | 3,189,377 |
| 1921 | 328,444 | 331,219 | [a] | 758,521 | 134,650 | 2,166 | [a] | 1,091,906 |
| 1922 | 385,653 | 359,793 | [a] | [b]966,315 | 313,745 | 4,514 | [a] | 1,330,622 |

[a] Quantity not reported.

[b] Includes also value of "built up, washers, and other manufactures" ($20,899) imported Sept. 22 to Dec. 31. Not separately classified prior to new tariff.

*Mica exported from the United States, 1917–1922.*

| | | | |
|---|---|---|---|
| 1917 | $74,485 | 1920 | $316,169 |
| 1918 | 74,529 | 1921 | 153,990 |
| 1919 | 109,348 | 1922 | 129,186 |

## MILLSTONES.

[See Abrasive materials.]

## MINERAL PAINTS.

*Domestic zinc and lead pigments,[a] made directly from ores, sold in the United States 1917–1922.*

| Year. | Short tons. | Value. | Year. | Short tons. | Value. |
|---|---|---|---|---|---|
| 1917 | 140,636 | $26,972,137 | 1920 | 143,244 | $24,564,572 |
| 1918 | 135,746 | 26,464,590 | 1921 | 102,463 | 14,801,032 |
| 1919 | 155,648 | 25,810,671 | 1922 | 162,815 | 22,205,400 |

[a] Include sublimed blue lead, sublimed white lead, leaded zinc oxide, and zinc oxide.

The canvass of natural mineral pigments was discontinued after 1915. Iron ore sold for paint in 1917–1922 is shown below.

*Iron ore, produced in the United States, sold for paint in 1917–1922.*

| Year. | Short tons. | Value. | Year. | Short tons. | Value. |
|---|---|---|---|---|---|
| 1917 | 20,895 | $56,859 | 1920 | 27,382 | $112,364 |
| 1918 | 10,034 | 22,924 | 1921 | 11,624 | 56,824 |
| 1919 | 17,885 | 84,630 | 1922 | 30,668 | 166,682 |

## MINERAL WATERS.

### PRODUCTION.

*Domestic mineral waters sold in the United States, 1918–1922.*

| Year. | Gallons. | Value. |
|---|---|---|
| 1918 | 40,709,722 | $4,533,001 |
| 1919 | 38,697,280 | 4,880,186 |
| 1920 | 36,218,260 | 4,860,915 |
| 1921 | 34,781,238 | 4,876,445 |
| 1922 | 38,492,881 | 5,498,269 |

### IMPORTS AND EXPORTS.

*Mineral waters imported for consumption in the United States, 1918–1922.*

| Year. | | | Gallons. | Value. |
|---|---|---|---|---|
| 1918 | Natural and artificial | Jan.–June | 258,791 | $123,695 |
| | Natural [a] | July–Dec. | 200,786 | 102,970 |
| | Artificial [a] | July–Dec. | 29,910 | 14,976 |
| 1919 | Natural | | 193,933 | 112,732 |
| | Artificial | | 9,081 | 4,216 |
| 1920 | Natural | | 466,547 | 177,992 |
| | Artificial | | 60,567 | 25,909 |
| 1921 | Natural | | 498,090 | 156,297 |
| | Artificial | | 26,675 | 10,804 |
| 1922 | Natural [a] | Jan. 1–Sept. 21 | 430,135 | 148,731 |
| | Artificial [a] | Jan. 1–Sept. 21 | 26,223 | 10,547 |
| | Natural and artificial | Sept. 22–Dec. 31 | 242,393 | 109,967 |

[a] Not separately shown prior to July, 1918, and after Sept. 21, 1922.

Large quantities of a few domestic waters are exported, but no figures are available prior to 1922, when 209,219 gallons of natural and artificial mineral waters, valued at $169,473, were exported.

## MOLYBDENUM.

### PRODUCTION.

In 1922, as in 1921, no production of molybdenum ores in the United States was reported to the United States Geological Survey. The mines remained closed for lack of market, for although molybdenum was used in the manufacture of steel, the ore imported added to the stocks on hand was sufficient to supply the demand.

*Molybdenum in ore and concentrates, produced in the United States, sold in 1917–1922.*

| Year. | Pounds. | Value. | Year. | Pounds. | Value. |
|---|---|---|---|---|---|
| 1917 | 350,200 | $495,350 | 1920 | 34,900 | $17,207 |
| 1918 | 861,637 | 1,253,700 | 1921 | | |
| 1919 | 297,926 | 341,814 | 1922 | | |

IMPORTS AND EXPORTS.

*"Molybdenum ore (steel-hardening)" imported for consumption in the United States, 1918–1922.*

| Year. | Pounds. | Value. | Year. | Pounds. | Value. |
|---|---|---|---|---|---|
| 1918—July to December [a] | 140,222 | $123,924 | 1921 | 29,783 | $20,471 |
| 1919 | 106,743 | 77,572 | 1922 | 412,221 | 90,015 |
| 1920 | 15,639 | 9,707 | | | |

[a] Not separately classified prior to July, 1918.

For imports of ferromolybdenum see under Ferroalloys. Exports of ferromolybdenum are not separately classified.

## NICKEL.

### PRODUCTION.

In 1922, as in 1921, the United States produced no nickel from domestic materials except as a by-product of copper refining, as shown in the following table. In 1919 the production of nickel was begun from complex sulphides mined on the property of the Missouri Cobalt Co. near Fredericktown, Mo., and in 1920 the company produced 80,626 pounds of shot nickel and 256,767 pounds of nickel hydrate, though it did not operate during the whole year. Large quantities of nickel matte imported from Canada and smaller quantities of matte from New Caledonian ore are, however, refined in the United States, though only Canadian matte was refined in 1920, 1921, and 1922. In 1922 for practically the first time in many years competition of nickel refined in a foreign country was seen in the United States when the Mond Nickel Co. of England established an agency here for the sale of its metal refined by the carbonyl process.

*Nickel content of nickel salts and metallic nickel produced in the United States as a by-product in the electrolytic refining of copper, 1917–1922, and from mixed ores in 1919 and 1920.*

| Year. | Short tons. | Value. | Year. | Short tons. | Value. |
|---|---|---|---|---|---|
| 1917 | 402 | $331,556 | 1920 [a] | 365 | $293,250 |
| 1918 | 441 | 401,000 | 1921 | 111 | 86,000 |
| 1919 [a] | 511 | 434,485 | 1922 | 208 | 133,191 |

[a] Including nickel produced from copper-lead-cobalt-nickel ores mined in Missouri.

## IMPORTS AND EXPORTS.

*Nickel imported for consumption in the United States, 1918-1922.*

| Year. | Nickel, nickel ore and matte, nickel oxide, and alloys of nickel with copper, etc. | | Manufactures and nickel sheets and strips. | Total value. |
|---|---|---|---|---|
| | Pounds. | Value. | | |
| 1918 | 73,207,147 | $11,520,775 | $115,243 | $11,636,018 |
| 1919 | 36,562,388 | 8,334,135 | 90,451 | 8,424,586 |
| 1920 | 48,492,076 | 10,657,193 | 200,464 | 10,857,657 |
| 1921 | 4,396,119 | 1,210,317 | 107,155 | 1,317,472 |
| 1922 | 14,919,362 | 3,945,168 | 110,176 | 4,055,344 |

*Nickel imported for consumption in the United States, 1921 and 1922, by classes.*

| Class. | 1921 | | 1922 | |
|---|---|---|---|---|
| | Pounds. | Value. | Pounds. | Value. |
| Nickel ore (nickel content) | 660,067 | $129,053 | 3,085,632 | $396,726 |
| Nickel matte (nickel content) | 1,382,111 | 303,733 | | |
| Nickel, alloys, pig, bars, etc | 2,324,993 | 770,021 | 11,341,360 | 3,438,225 |
| Nickel oxide | 28,948 | 7,510 | 492,370 | 110,217 |
| All other manufactures | (a) | 107,155 | (a) | 110,176 |
| | | 1,317,472 | | 4,055,344 |

[a] Quantity not recorded.

*Nickel, nickel oxide, and matte exported from the United States, 1917-1922.*

| Year. | Pounds. | Value. | Year. | Pounds. | Value. |
|---|---|---|---|---|---|
| 1917 | 21,992,820 | $8,936,620 | 1920 | 1,215,232 | $574,845 |
| 1918 | 17,469,500 | 6,927,041 | 1921 | 425,851 | 103,372 |
| 1919 | 3,810,656 | 1,697,544 | 1922 | 9,317,520 | 1,016,091 |

Beginning with 1922, additional classes of nickel exports are shown. The complete exports for the year are given in the following table:

*Nickel exported from the United States in 1922, by classes.*

| Class. | Pounds. | Value. |
|---|---|---|
| Oxide and matte | 9,311,680 | $1,013,069 |
| Nickel | 5,840 | 3,022 |
| Monel metal and other alloys | 913,983 | 196,702 |
| Manufactures | 249,467 | 179,094 |
| Nickel or German silver in bars, rods, or sheets | 402,922 | 121,755 |

## OILSTONES AND SCYTHESTONES.

[See Abrasive materials.]

## ORE.

*Crude metallic ores shipped from or treated at the mine in the United States, 1918–1922, in short tons.*

[Figures rounded.]

| Class of ore. | 1918 | 1919 | 1920 | 1921 | 1922 |
|---|---|---|---|---|---|
| Aluminum ore (bauxite)[a] | 678,000 | 422,000 | 584,000 | 156,000 | 347,000 |
| Chromite | 92,000 | 6,000 | 3,000 | 300 | 400 |
| Dry and siliceous (gold and silver) ore | 9,702,000 | 9,302,000 | 8,590,000 | 8,436,000 | 8,728,000 |
| Iron ore [b] | 80,572,000 | 63,050,000 | 77,539,000 | 29,750,000 | 56,641,000 |
| Manganese ore (35 per cent or more Mn.) [b] | 343,000 | 62,000 | 106,000 | 15,000 | 15,000 |
| Manganiferous ore (5 to 35 per cent Mn.) [b] | 1,181,000 | 363,000 | 713,000 | 80,000 | 668,000 |
| Quicksilver ore | 416,000 | 188,000 | 109,000 | 35,000 | 43,000 |
| Copper ore: | | | | | |
| Western States | 49,985,000 | 27,841,000 | 30,236,000 | 9,221,000 | 21,383,000 |
| Central States | 11,321,000 | 7,690,000 | 5,939,000 | 3,611,000 | 4,952,000 |
| Eastern States | 983,000 | 591,000 | 590,000 | 564,000 | 558,000 |
| | 62,289,000 | 36,122,000 | 36,765,000 | 13,396,000 | 26,893,000 |
| Copper-lead and copper-lead-zinc ore | 16,000 | 18,000 | 27,000 | 14,000 | 52,000 |
| Lead ore: | | | | | |
| Western States | 2,356,000 | 1,815,000 | 2,368,000 | 2,054,000 | 2,124,000 |
| Central States | 5,533,000 | 4,304,000 | 4,822,000 | 5,075,000 | 5,162,000 |
| Eastern States | 43 | 8,000 | 10,000 | | 2,000 |
| | 7,889,000 | 6,127,000 | 7,200,000 | 7,129,000 | 7,288,000 |
| Lead-zinc ore: | | | | | |
| Western States | 2,352,000 | 1,366,000 | 1,444,000 | 122,000 | 445,000 |
| Central States | [c] 13,053,000 | 10,234,000 | 10,939,000 | 3,614,000 | 8,110,000 |
| Eastern States | 58,000 | | | | |
| | [c] 15,463,000 | 11,600,000 | 12,383,000 | 3,736,000 | 8,555,000 |
| Zinc ore: | | | | | |
| Western States | 210,000 | 89,000 | 482,000 | 10,000 | 471,000 |
| Central States | [c] 46,000 | 949,000 | 1,058,000 | 933,000 | 1,206,000 |
| Eastern States | 1,313,000 | 1,331,000 | 1,111,000 | 765,000 | 990,000 |
| | [c] 1,569,000 | 2,369,000 | 2,651,000 | 1,708,000 | 2,667,000 |
| Grand total | 180,210,000 | 129,629,000 | 146,670,000 | 64,455,000 | 111,897,000 |

[a] Figures represent ore mined.
[b] Exclusive of fluxing ore.
[c] Prior to 1919 practically all the zinc-bearing ores in Central States were classed as lead-zinc ores. In 1919–1922 a closer separation was made so that the figures are not comparable with earlier years.

## PEAT.

### PRODUCTION.

*Peat produced in the United States, 1918–1922, by uses.*

| Year. | Fertilizer and fertilizer ingredient. | | Stock food. | | Fuel. | | Other products.[a] | | Total. | |
|---|---|---|---|---|---|---|---|---|---|---|
| | Short tons. | Value. | Short tons. | Value. | Short tons. | Value. | Short tons. | Value. | Short tons. | Value. |
| 1918 | 79,573 | $775,313 | 7,096 | $106,935 | 20,567 | $164,745 | 25 | $250 | 107,261 | $1,047,243 |
| 1919 | 54,690 | 557,240 | 6,402 | 98,940 | (b) | (b) | 8,105 | 49,352 | 69,197 | 705,532 |
| 1920 | 63,272 | 773,635 | [c] 9,182 | [c] 143,047 | 750 | 5,050 | (c) | (c) | 73,204 | 921,732 |
| 1921 | 29,460 | 251,046 | [c] 946 | [c] 9,073 | (c) | (c) | (c) | (c) | 30,406 | 260,119 |
| 1922 | 57,747 | 369,165 | [c] 1,893 | [c] 20,864 | 1,040 | 7,700 | (c) | (c) | 60,680 | 397,729 |

[a] Peat moss, stable litter, and packing material. Also peat for fuel in 1919.
[b] Included under "Other products."
[c] Small quantity of miscellaneous products included under "Stock food." Also peat for fuel in 1921.

## IMPORTS.

*Peat moss imported for consumption in the United States, 1917-1922.*

| Year. | Short tons. | Value. | Year. | Short tons. | Value. |
|---|---|---|---|---|---|
| 1917 | 506 | $4,966 | 1920 | 2,762 | $36,201 |
| 1918 | | | 1921 | 3,450 | 22,754 |
| 1919 | 464 | 16,345 | 1922 | 4,805 | 24,489 |

No exports of peat are reported.

## PETROLEUM.

### PRODUCTION.

*Petroleum produced in the United States, 1920-1922, by fields.*

[Barrels of 42 United States gallons.]

| Field. | 1920 | | 1921 | | 1922 | |
|---|---|---|---|---|---|---|
| | Barrels. | Value at wells. | Barrels. | Value at wells. | Barrels. | Value at wells. |
| Appalachian | 30,630,000 | $163,994,000 | 30,451,000 | $87,896,000 | 29,180,000 | $80,448,000 |
| Lima-Indiana | 2,407,000 | 8,757,000 | 2,404,000 | 5,423,000 | 2,269,000 | 5,063,000 |
| Illinois and southwest Indiana | 11,427,000 | 41,949,000 | 10,934,000 | 22,486,000 | 10,231,000 | 21,018,000 |
| Mid-Continent | 250,111,000 | 840,700,000 | 258,461,000 | 426,720,000 | 310,992,000 | 532,738,000 |
| Gulf coast | 27,682,000 | 75,595,000 | 36,371,000 | 43,037,000 | 37,117,000 | 44,313,000 |
| Rocky Mountain | 17,282,000 | 51,294,000 | 20,950,000 | 26,033,000 | 29,261,000 | 38,117,000 |
| California | 103,377,000 | 178,395,000 | 112,600,000 | 203,138,000 | 138,468,000 | 173,381,000 |
| Other fields[a] | 13,000 | 61,000 | 12,000 | 12,000 | 13,000 | 33,000 |
| | 442,929,000 | 1,360,745,000 | 472,183,000 | 814,745,000 | 557,531,000 | 895,111,000 |

[a] 1920: Alaska, Arkansas, Missouri, New Mexico, and Utah; 1921–1922: Alaska, Missouri, and New Mexico.

*Petroleum produced in the United States, 1920-1922, by States.*

| State. | 1920 | | 1921 | | 1922 | |
|---|---|---|---|---|---|---|
| | Barrels. | Value at wells. | Barrels. | Value at wells. | Barrels. | Value at wells. |
| Alaska | [a] | [a] | [a] | [a] | [a] | [a] |
| Arkansas | [a] | [a] | 10,473,000 | $12,746,000 | 12,712,000 | $20,416,000 |
| California | 103,377,000 | $178,395,000 | 112,600,000 | 203,138,000 | 138,468,000 | 173,381,000 |
| Colorado | 111,000 | 199,000 | 108,000 | 132,000 | 97,000 | 114,000 |
| Illinois | 10,774,000 | 39,583,000 | 10,043,000 | 20,632,000 | 9,383,000 | 19,291,000 |
| Indiana | 945,000 | 3,407,000 | 1,158,000 | 2,414,000 | 1,087,000 | 2,225,000 |
| Kansas | 39,005,000 | 133,469,000 | 36,456,000 | 68,694,000 | 31,766,000 | 56,131,000 |
| Kentucky | 8,738,000 | 34,279,000 | 9,013,000 | 16,736,000 | 8,973,200 | 17,758,000 |
| Louisiana | 35,714,000 | 112,606,000 | 27,103,000 | 42,469,000 | 35,376,000 | 53,169,000 |
| Missouri | [a] | [a] | [a] | [a] | [a] | [a] |
| Montana | 340,000 | 1,045,000 | 1,509,000 | 2,373,000 | 2,449,000 | 4,048,000 |
| New Mexico | [a] | [a] | [a] | [a] | [a] | [a] |
| New York | 906,000 | 5,433,000 | 988,000 | 3,262,000 | 1,000,000 | 3,144,000 |
| Ohio | 7,400,000 | 37,338,000 | 7,335,000 | 21,512,000 | 6,781,000 | 17,369,000 |
| Oklahoma | 106,206,000 | 356,439,000 | 114,634,000 | 183,185,000 | 149,571,000 | 258,160,000 |
| Pennsylvania | 7,438,000 | 44,464,000 | 7,418,000 | 24,746,000 | 7,425,000 | 23,834,000 |
| Tennessee | 14,000 | 50,000 | 12,000 | 21,000 | 9,800 | 17,000 |
| Texas | 96,868,000 | 313,781,000 | 106,166,000 | 162,663,000 | 118,684,000 | 189,175,000 |
| Utah | [a] | [a] | | | | |
| West Virginia | 8,249,000 | 50,146,000 | 7,822,000 | 26,482,000 | 7,021,000 | 22,891,000 |
| Wyoming | 16,831,000 | 50,050,000 | 19,333,000 | 23,528,000 | 26,715,000 | 33,955,000 |
| Undistributed[b] | 13,000 | 61,000 | 12,000 | 12,000 | 13,000 | 33,000 |
| | 442,929,000 | 1,360,745,000 | 472,183,000 | 814,745,000 | 557,531,000 | 895,111,000 |

[a] Included under "Undistributed."

[b] 1920: Alaska, Arkansas, Missouri, New Mexico, and Utah; 1921–1922: Alaska, Missouri, and New Mexico.

*World's production of petroleum in 1922 and since 1857, by countries.*

| Country | 1922 | | | | 1857–1922 | | | |
|---|---|---|---|---|---|---|---|---|
| | Barrels of 42 United States gallons. | Metric tons. | Cubic meters. | Percentage of total by volume. | Barrels of 42 United States gallons. | Metric tons. | Cubic meters. | Percentage of total by volume. |
| United States | 557,531,000 | 76,415,000 | 88,636,000 | 65.0 | 6,459,582,000 | 884,824,000 | 1,026,944,000 | 62.3 |
| Mexico | [a] 182,278,000 | 27,312,000 | [a] 28,979,000 | 21.2 | 912,199,000 | 136,336,000 | 145,021,000 | 8.8 |
| Russia | 35,692,000 | [b] 4,864,000 | 5,675,000 | 4.2 | 1,968,681,000 | 260,885,000 | 312,981,000 | 19.0 |
| Persia | [c] 22,247,000 | 2,966,000 | 3,537,000 | 2.6 | 89,919,000 | 11,989,000 | 14,296,000 | .9 |
| Dutch East Indies | 16,720,000 | [d] 2,324,000 | 2,658,000 | 1.9 | 253,341,000 | 34,393,000 | 40,276,000 | 2.4 |
| Rumania | 9,843,000 | [e] 1,369,000 | 1,565,000 | 1.1 | 183,672,000 | 25,790,000 | 29,200,000 | 1.8 |
| India | [f] 8,529,000 | 1,197,000 | 1,356,000 | 1.0 | 140,724,000 | 18,822,000 | 22,372,000 | 1.3 |
| Peru | [g] 5,314,000 | [g] 701,000 | [g] 845,000 | .6 | 38,810,000 | 5,158,000 | 6,171,000 | .4 |
| Poland (Galicia) | 5,227,000 | [h] 713,000 | 831,000 | .6 | 179,574,000 | 24,834,000 | 28,549,000 | 1.7 |
| Argentina | 3,018,000 | [i] 439,000 | 480,000 | .4 | 12,286,000 | 1,807,000 | 1,953,000 | |
| British Borneo (Sarawak) | 2,849,000 | [j] 410,000 | 453,000 | .3 | 8,402,000 | 1,209,000 | 1,336,000 | |
| Trinidad | [k] 2,445,000 | 340,000 | 389,000 | .3 | 16,156,000 | 2,247,000 | 2,568,000 | |
| Venezuela | 2,201,000 | [l] 335,000 | 350,000 | .3 | 4,969,000 | 756,000 | 790,000 | |
| Japan and Taiwan (Formosa) | [m] 2,055,000 | 285,000 | 327,000 | .2 | 45,876,000 | 6,372,000 | 7,293,000 | |
| Egypt | 1,188,000 | [n] 173,000 | 189,000 | | 9,582,000 | 1,378,000 | 1,523,000 | |
| France (Alsace) | 496,000 | [o] 70,000 | 79,000 | | 1,938,000 | 273,000 | 308,000 | |
| Colombia | [p] 325,000 | 46,000 | 51,000 | | 323,000 | 46,000 | 51,000 | 1.4 |
| Germany | 319,000 | [q] 45,000 | 51,000 | | 15,987,000 | 2,153,000 | 2,542,000 | |
| Canada | [r] 179,000 | 25,000 | 28,000 | | 25,230,000 | 3,365,000 | 4,011,000 | |
| Czechoslovakia | 120,000 | [s] 18,000 | 19,000 | .3 | 331,000 | 49,000 | 53,000 | |
| Italy | 31,000 | [t] 4,000 | 5,000 | | 1,107,000 | 157,000 | 176,000 | |
| Algeria [u] | 9,000 | | | | 50,000 | 7,000 | 8,000 | |
| England [v] | 1,000 | 15,000 | 17,000 | | 9,000 | 78,000 | 92,000 | |
| Other | 100,000 | | | | 566,000 | | | |
| | 858,715,000 | 120,066,000 | 136,520,000 | 100.0 | 10,369,314,000 | 1,422,928,000 | 1,648,514,000 | 100.0 |

[a] Boletín del petróleo, Feb., 1923.
[b] Gornyi Zhurnal, 1923.
[c] Anglo-Persian Oil Co. (Ltd.).
[d] Royal Dutch Shell Co. only, Commerce Repts., Aug. 1923.
[e] Moniteur du petrole roumain, Mar. 1, 1923.
[f] India Geol. Survey.
[g] Cuerpo de ingenieros de minas, chief Bur. of Statistics.
[h] American legation, Warsaw.
[i] Estimate based on report of director general of mines for part of year.
[j] Royal Dutch Shell Co.
[k] Inspector of Mines, Trinidad.
[l] Ministerio del fomento Mem.
[m] Dept. of Agriculture and Commerce of Japan, Section of Statistics.
[n] Ministry of Finance, Cairo.
[o] Trade commissioner's rept. to Dept. of Commerce, Oct. 1, 1923.
[p] International Petroleum Co.
[q] Braunkhole, Sept. 15, 1923.
[r] Dominion Bur. Statistics.
[s] Commerce Repts., May 7, 1923.
[t] Rivista del servizio minerario.
[u] Bur. of Mines, governor general of Algiers.
[v] Rept. Secretary for Mines and H. M. Chief Inspector of Mines, Mines Dept. Ann. Rept.

## STOCKS.

*Stocks of crude petroleum held in the United States on December 31, 1921–1922, in barrels of 42 U. S. gallons.*

| | | 1921 | 1922 |
|---|---|---|---|
| Domestic petroleum—pipe-line and tank-farm stocks: | | | |
| East of California— | | | |
| Appalachian— | | | |
| New York, Pennsylvania, West Virginia, eastern and central Ohio | gross | 4,933,000 | 6,200,000 |
| | net | 4,670,000 | 5,941,000 |
| Kentucky | gross | 2,264,000 | 3,041,000 |
| | net | 2,168,000 | 2,927,000 |
| Lima-Indiana | gross | 1,386,000 | 939,000 |
| | net | 1,014,000 | 685,000 |
| Illinois and southwest Indiana | gross | 8,066,000 | 10,641,000 |
| | net | 7,567,000 | 10,140,000 |
| Mid-Continent— | | | |
| Oklahoma, Kansas, central and north Texas | gross | 102,012,000 | 147,456,000 |
| | net | 91,983,000 | 136,601,000 |
| North Louisiana and Arkansas | gross | 10,912,000 | 16,617,000 |
| | net | 10,418,000 | 15,972,000 |
| Gulf coast | gross | 17,973,000 | 26,373,000 |
| | net | 17,606,000 | 24,781,000 |
| Rocky Mountain | gross | 1,647,000 | 2,002,000 |
| | net | 1,635,000 | 1,991,000 |
| Total pipe-line and tank-farm stocks east of California | gross | 149,193,000 | 213,269,000 |
| | net | 137,061,000 | 199,038,000 |
| California—Gross pipe-line, tank-farm, and producers' stocks | | 35,022,000 | 49,375,000 |
| Mexican petroleum held in the United States by importers: | | | |
| At Atlantic coast stations— | | | |
| Crude | | 5,712,000 | 6,028,000 |
| Topped oil topped in Mexico | | 1,599,000 | 2,642,000 |
| At Gulf coast stations— | | | |
| Crude | | 5,413,000 | 6,059,000 |
| Topped oil topped in Mexico | | 816,000 | 1,436,000 |
| Total Mexican | | 13,540,000 | 16,165,000 |
| Total of net pipe-line and tank-farm stocks east of California, gross pipe-line, tank-farm, and producers' stocks in California, and stocks of Mexican petroleum held in the United States by importers | | 185,623,000 | 264,578,000 |
| Producers' stocks (excluding California) | | 5,139,000 | 8,428,000 |
| | | 190,762,000 | 273,006,000 |

## CONSUMPTION.

*Indicated deliveries to consumers of domestic and imported crude petroleum in the United States, 1921–1922, in barrels of 42 U. S. gallons.*

| | 1921 | 1922 |
|---|---|---|
| Domestic petroleum (by field of origin): | | |
| Appalachian | 27,188,000 | 27,184,000 |
| Lima-Indiana | 2,439,000 | 2,589,000 |
| Illinois and southwest Indiana | 6,346,000 | 7,649,000 |
| Mid-Continent | 230,494,000 | 257,838,000 |
| Gulf coast | 29,519,000 | 30,037,000 |
| Rocky Mountain | 19,890,000 | 28,487,000 |
| California | 99,818,000 | 124,115,000 |
| Other | 12,000 | 13,000 |
| Consumption and exports [a] | 415,706,000 | 477,912,000 |
| Exports | 8,866,000 | 9,995,000 |
| Consumption in the United States and Territories | 406,840,000 | 467,917,000 |
| Imported petroleum: Consumption in the United States and Territories [b] | 119,192,000 | 124,515,000 |
| Consumption of domestic and imported petroleum in the United States and Territories | 526,032,000 | 592,432,000 |

[a] Production plus domestic stocks at beginning of year minus domestic stocks at end of year.
[b] Imports of "mineral crude oil" minus exports of foreign crude oil plus decrease or minus increase of stocks of Mexican petroleum held in the United States by importers.

### IMPORTS AND EXPORTS.

*Crude petroleum imported into and exported from the United States, 1918–1922.*

| Year. | Imports.[a] | | Exports.[b] | |
|---|---|---|---|---|
| | Barrels. | Value. | Barrels. | Value. |
| 1918 | 37,735,641 | $21,319,464 | 4,900,691 | $12,084,250 |
| 1919 | 52,821,567 | 26,442,881 | 5,924,320 | 14,805,546 |
| 1920 | 106,175,289 | 55,799,254 | 8,044,907 | 28,990,444 |
| 1921 | 125,363,983 | 66,547,379 | 8,865,497 | 20,204,491 |
| 1922 | 127,308,423 | 70,383,309 | 9,995,093 | 18,348,110 |

[a] Imports of crude petroleum into the United States are chiefly from Mexico, with small quantities from other countries. Prior to September 22, 1922, topped oil was included in imports of crude petroleum.

[b] Exports of crude petroleum are chiefly to Canada. Exports of refined products and shipments of crude petroleum to Alaska, Hawaii, Porto Rico, and the Philippine Islands, and foreign petroleum reexported are not included.

## PHOSPHATE ROCK.

### PRODUCTION.

*Phosphate rock, produced in the United States, sold in 1917–1922.*

| Year. | Long tons. | Value. | Year. | Long tons. | Value. |
|---|---|---|---|---|---|
| 1917 | 2,584,287 | $7,771,084 | 1920 | 4,103,982 | $25,079,572 |
| 1918 | 2,490,760 | 8,214,463 | 1921 | 2,064,025 | 12,270,070 |
| 1919 | 2,271,983 | 11,591,268 | 1922 | 2,417,883 | 10,482,846 |

### IMPORTS AND EXPORTS.

*Phosphate rock, imported for consumption in the United States, 1917–1922.*

| Year. | Long tons. | Value. | Year. | Long tons. | Value. |
|---|---|---|---|---|---|
| 1917 | 92 | $1,169 | 1920 | 63 | $2,090 |
| 1918 | | | 1921 | 3,535 | 43,960 |
| 1919 | 34 | 457 | 1922 | 5,890 | 95,846 |

*Phosphate rock exported from the United States, 1917–1922.*

| Year. | Long tons. | Value. | Year. | Long tons. | Value. |
|---|---|---|---|---|---|
| 1917 | 166,358 | $835,045 | 1920 | 1,069,712 | $10,570,175 |
| 1918 | 143,455 | 912,485 | 1921 | 733,312 | 7,320,137 |
| 1919 | 378,731 | 3,567,982 | 1922 | 719,294 | 5,858,167 |

## PLATINUM AND ALLIED METALS.

### PRODUCTION.

Reports received from refiners of platinum, gold bullion, nickel, and copper indicate that 57,718 troy ounces of refined new metals of the platinum group were recovered in 1922, of which about 3,373 ounces are believed to be of domestic origin.

*New platinum and allied metals recovered by refiners in the United States, 1918–1922, in troy ounces.*

| Year. | Platinum. | Palladium. | Iridium. | Osmiridium. | Other. | Total. |
|---|---|---|---|---|---|---|
| 1918 | 54,399 | 4,024 | 465 | 539 | 326 | 59,753 |
| 1919 | 40,220 | 3,807 | 401 | 402 | 279 | 45,109 |
| 1920 | 36,015 | 4,309 | 418 | 409 | 393 | 41,544 |
| 1921 | 51,791 | 2,686 | 286 | 581 | 1,026 | 56,370 |
| 1922 | 54,142 | 1,943 | 210 | 1,301 | 122 | 57,718 |

Dealers and refiners reported recovery in 1922 of 46,688 ounces of secondary platinum metals derived from refining scrap and sweeps. The figures that make up this total probably represent some duplication, as the same metal may be handled as scrap several times in a year.

*Secondary platinum and allied metals recovered in the United States, 1918–1922, in troy ounces.*

| Year. | Platinum. | Palladium. | Iridium. | Other. | Total. |
|---|---|---|---|---|---|
| 1918 | 40,378 | 1,795 | 3,410 | ---------- | 45,583 |
| 1919 | 54,545 | 3,467 | 3,504 | ---------- | 61,516 |
| 1920 | 51,255 | 3,100 | 3,355 | ---------- | 57,710 |
| 1921 | 39,131 | 4,887 | 1,776 | 229 | 46,023 |
| 1922 | 40,062 | 4,193 | 1,937 | 496 | 46,688 |

## IMPORTS AND EXPORTS.

*Platinum and allied metals imported for consumption in the United States, 1921–1922.*

| Metal. | 1921 | | 1922 | |
|---|---|---|---|---|
| | Troy ounces. | Value. | Troy ounces. | Value. |
| Platinum or crude platinum and unmanufactured products, ingots, bars, sheets, wire, etc | 62,097 | $4,129,639 | 94,939 | $7,790,898 |
| Platinum, manufactured products, vases, retorts, etc | 63 | [a] 14,120 | 18 | [a] 9,548 |
| Iridium | 1,345 | 277,597 | 1,899 | 298,567 |
| Osmiridium | 2,603 | 296,277 | 2,165 | 242,637 |
| Osmium | 161 | 13,239 | 1,012 | 81,231 |
| Palladium | 11,348 | 629,965 | 9,754 | 537,684 |
| Rhodium | 609 | 53,359 | 111 | 16,227 |
| Ruthenium | 152 | 4,268 | 100 | 4,839 |
| | 78,378 | 5,418,464 | 109,998 | 8,981,631 |

[a] Includes articles to the value of $6,947 in 1921 and $6,735 in 1922, imported under duty, quantity not given.

*Platinum exported from the United States, 1918–1922.*

| Year. | | Unmanufactured. | | Manufactures of, except jewelry. | |
|---|---|---|---|---|---|
| | | Troy ounces. | Value. | Troy ounces. | Value. |
| 1918 | | 119 | $13,511 | (a) | $23,562 |
| 1919 | | 522 | 75,066 | (a) | 54,529 |
| 1920 | | 1,302 | 177,115 | (a) | 111,014 |
| 1921 | | 3,272 | 244,473 | 741 | 85,216 |
| 1922 | Crude, scrap, and old | 143 | 13,149 | 486 | 35,967 |
| | Ingots, sheets, wire, and alloys | 1,313 | 127,047 | | |

[a] Quantity not given.

## POTASH.

### PRODUCTION.

*Potash produced and sold in the United States in 1918–1922.*

| Year. | Produced. | | | Sold. | | |
|---|---|---|---|---|---|---|
| | Number of plants. | Crude potash (short tons). | Available content of potash ($K_2O$) (short tons). | Crude potash (short tons). | Available content of potash ($K_2O$) (short tons). | Value. |
| 1918 | 128 | 207,686 | 54,803 | 140,343 | 38,580 | $15,839,618 |
| 1919 | 102 | 116,634 | 32,474 | 166,063 | 45,728 | 11,271,269 |
| 1920 | 66 | 166,834 | 48,077 | 139,963 | 41,444 | 7,463,026 |
| 1921 | 20 | 25,485 | 10,171 | 10,337 | 4,408 | 447,859 |
| 1922 | 12 | 25,176 | 11,714 | 22,028 | 11,313 | 463,512 |

*Potash produced and sold in the United States in 1921 and 1922, by sources.*

| Source. | Produced | | | | Sold. | | |
|---|---|---|---|---|---|---|---|
| | Number of plants. | Crude potash (short tons). | Available content of potash ($K_2O$). | | Crude potash (short tons). | Available content of potash ($K_2O$) (short tons). | Value f. o. b. plant. |
| | | | Short tons. | Percentage of total. | | | |
| **1921.** | | | | | | | |
| Mineral: | | | | | | | |
| Natural brines | 7 | 11,907 | 6,057 | 59.6 | 6,376 | 3,078 | $281,630 |
| Dust from cement mills | 3 | 3,366 | 1,037 | 10.2 | [a] 256 | 82 | 12,923 |
| Dust from blast furnaces | 5 | 1,257 | 106 | 1.0 | 580 | 50 | 5,018 |
| Organic: | | | | | | | |
| Molasses distillery waste, Steffens waste water from beet-sugar refineries, and wood ashes | 5 | 8,955 | 2,971 | 29.2 | 3,125 | 1,198 | 148,288 |
| | 20 | 25,485 | 10,171 | 100.0 | 10,337 | 4,408 | 447,859 |
| **1922.** | | | | | | | |
| Mineral: | | | | | | | |
| Natural brines<br>Dust from cement mills<br>Dust from blast furnaces | 8 | 18,291 | 9,319 | 79.6 | 19,968 | 10,556 | 414,041 |
| Organic: | | | | | | | |
| Molasses distillery waste | 2 | 6,581 | 2,299 | 19.6 | 2 | 1 | 30 |
| Steffens waste water from beet-sugar refineries | 2 | 304 | 96 | .8 | 2,058 | 756 | 49,441 |
| | 12 | 25,176 | 11,714 | 100.0 | 22,028 | 11,313 | 463,512 |

[a] Includes potash from alunite.

*Potash produced in United States in 1921 and 1922, by States.*

| State. | Number of plants. | Crude potash (short tons). | Available content of potash ($K_2O$). | |
|---|---|---|---|---|
| | | | Short tons. | Percentage of total. |
| **1921.** | | | | |
| California | 6 | 13,075 | 6,187 | 61 |
| Pennsylvania | 5 | 1,257 | 106 | 1 |
| Other States [a] | 9 | 11,153 | 3,878 | 38 |
| | 20 | 25,485 | 10,171 | 100 |
| **1922.** | | | | |
| California | 4 | 17,551 | 9,363 | 79.9 |
| Indiana | 1 | 100 | 30 | .3 |
| Maryland | 1 | 6,535 | 2,287 | 19.5 |
| Pennsylvania | 5 | 990 | 34 | .3 |
| Porto Rico | 1 | | | |
| | 12 | 25,176 | 11,714 | 100.0 |

[a] Two plants in Nebraska, two in Utah, and one each in Indiana, Maryland, New York, Tennessee, and Wisconsin.

## STOCKS.

*Potash held by producers in the United States, December 31, 1921 and 1922, in short tons.*

| Source. | 1921 | | 1922 | |
|---|---|---|---|---|
| | Crude potash. | Available content of potash ($K_2O$). | Crude potash. | Available content of potash ($K_2O$). |
| Mineral: | | | | |
| Natural brines | 18,763 | 8,194 | 11,289 | 5,771 |
| Dust from blast furnaces | 1,200 | 115 | 6,508 | 1,585 |
| Dust from cement mills | 3,745 | 1,259 | | |
| Alunite | | | | |
| Organic: | | | | |
| Molasses distillery waste | 9,217 | 3,057 | 12,203 | 4,267 |
| Steffens waste water from beet-sugar refineries | | | 100 | 30 |
| Wood ashes | | | | |
| | 32,925 | 12,625 | 30,100 | 11,653 |

## IMPORTS AND EXPORTS.

*Potash materials imported for consumption in the United States, 1918–1922.*

| Year. | Potash salts used mainly in the fertilizer industry.[a] | | | Potash salts used mainly in chemical industries.[b] | | | Total. | | |
|---|---|---|---|---|---|---|---|---|---|
| | Short tons. | | Value. | Short tons. | | Value. | Short tons. | | Value. |
| | Gross weight. | Potash ($K_2O$) content. | | Gross weight. | Potash ($K_2O$) content. | | Gross weight. | Potash ($K_2O$) content. | |
| 1918 | 525 | 261 | $117,438 | 23,894 | 7,696 | $8,790,398 | 24,419 | 7,957 | $8,907,836 |
| 1919 | 127,416 | 28,484 | 4,163,739 | 33,430 | 11,135 | 6,028,077 | 160,846 | 39,619 | 10,191,816 |
| 1920 | 918,698 | 197,795 | 33,885,627 | 63,564 | 26,997 | 9,504,156 | 982,262 | 224,792 | 43,389,783 |
| 1921 | 212,752 | 64,126 | 7,743,364 | 32,453 | 14,572 | 3,739,090 | 245,205 | 78,698 | 11,482,454 |
| 1922 | 632,711 | 186,264 | 10,951,197 | 34,198 | 15,151 | 4,415,891 | 666,909 | 201,415 | 15,367,088 |

[a] Includes kainite, manure salts, muriate, and sulphate. Considerable quantities of muriate and some sulphate were used in chemical industries.

[b] Includes bicarbonate, bichromate, bitartrate, carbonate, caustic, chlorate, chromate, cyanide, ferricyanide, ferrocyanide, iodide, nitrate, permanganate, and Rochelle salt.

*Domestic potash salts exported from the United States, 1921 and 1922.*

| Material. | 1921 | | | 1922 | | |
|---|---|---|---|---|---|---|
| | Short tons. | | Value. | Short tons. | | Value. |
| | Gross weight. | Potash ($K_2O$) content. | | Gross weight. | Potash ($K_2O$) content. | |
| Potassium chlorate | 188 | 71 | $49,709 | 281 | 107 | $51,066 |
| Potassium bichromate | (a) | | 286,284 | 2,215 | 886 | 433,552 |
| All other potassium salts | | | | 3,742 | | 296,378 |
| | | | 335,993 | 6,238 | | 780,996 |

[a] Figures not available prior to 1922.

## PUMICE.

[See Abrasive materials.]

## PYRITES.

### PRODUCTION.

*Pyrites produced in the United States, 1917–1922.*

| Year. | Long tons. | Value. | Year. | Long tons. | Value. |
|---|---|---|---|---|---|
| 1917 | 482,662 | $2,593,035 | 1920 | 310,777 | $1,596,961 |
| 1918 | 464,494 | 2,644,515 | 1921 | 157,118 | 711,432 |
| 1919 | 420,647 | 2,558,172 | 1922 | 169,043 | 671,241 |

### IMPORTS.

*Pyrites containing more than 25 per cent of sulphur imported for consumption in the United States, 1917–1922.*

| Year. | Long tons. | Value. | Year. | Long tons. | Value. |
|---|---|---|---|---|---|
| 1917 | 967,340 | $5,981,457 | 1920 | 332,606 | $1,660,832 |
| 1918 | 496,792 | 2,741,676 | 1921 | 216,229 | 818,852 |
| 1919 | 388,973 | 2,176,565 | 1922 | 279,445 | 1,199,076 |

Exports of "pyrites or other sulphur ore" in 1922 amounted to 323 long tons, valued at $4,325. Data for earlier years are not available.

## QUARTZ.

[See Silica.]

## QUICKSILVER.

### SUPPLY.

*Supplies of quicksilver in the United States, 1918–1922.*

[Flasks of 75 pounds.]

| Year. | Production. | | Imports for consumption. | | Exports. | | Apparent available supply.[a] | |
|---|---|---|---|---|---|---|---|---|
| | Flasks. | Value. | Flasks. | Value. | Flasks. | Value. | Flasks. | Value. |
| 1918 | 32,883 | $3,863,752 | 6,719 | $533,622 | 3,098 | $338,620 | 36,504 | $4,058,754 |
| 1919 | 21,415 | 1,933,560 | 10,635 | 791,226 | 9,107 | 817,328 | 22,943 | 1,907,458 |
| 1920 | 13,392 | 1,066,807 | 14,169 | 971,510 | 1,553 | 129,993 | 26,008 | 1,908,324 |
| 1921 | 6,339 | 300,595 | 10,601 | 457,993 | 393 | 18,869 | 16,547 | 739,719 |
| 1922 | 6,375 | 368,348 | 16,920 | 757,842 | 291 | 15,910 | 23,004 | 1,110,280 |

[a] Production plus imports minus exports.

### PRODUCTION.

*Quicksilver produced in the United States, 1920–1922, by States.*

| State. | 1920 | | 1921 | | 1922 | |
|---|---|---|---|---|---|---|
| | Flasks. | Value. | Flasks. | Value. | Flasks. | Value. |
| California | 9,849 | $784,571 | 3,055 | $144,868 | 3,405 | $196,741 |
| Texas | 3,436 | 273,712 | | | | |
| Oregon | 24 | 1,912 | 3,284 | 155,727 | 2,970 | 171,607 |
| Nevada | 83 | 6,612 | | | | |
| Idaho | | | | | | |
| | 13,392 | 1,066,807 | 6,339 | 300,595 | 6,375 | 368,348 |

### PRICES.

*Average yearly prices of quicksilver, per flask, in the United States and the United Kingdom, 1917–1922.*

| Year. | San Francisco [a] (domestic). | New York.[b] | London.[c] | Year. | San Francisco [a] (domestic). | New York.[b] | London.[c] |
|---|---|---|---|---|---|---|---|
| | | | £ s. d. | | | | £ s. d. |
| 1917 | $105.32 | $106.30 | 22 4 3 | 1920 | $79.66 | $81.12 | 20 14 9 |
| 1918 | 117.50 | 123.47 | [d] | 1921 | 47.42 | 45.46 | 11 3 5 |
| 1919 | 90.29 | 92.15 | 20 9 5½ | 1922 | 57.78 | 58.95 | 11 11 6 |

[a] 1917–1921: Min. and Sci. Press, San Francisco; 1922: Eng. and Min. Jour.-Press, New York.
[b] 1917–1921: Eng. and Min. Jour., New York; 1922: Eng. and Min. Jour.-Press, New York.
[c] Min. Jour., (London).
[d] Quoted as "nominal" only.

## RADIUM.

[See Uranium and vanadium ores.]

## SALT.

### PRODUCTION.

*Domestic salt sold in the United States, 1918–1922.*

| Year. | Short tons. | | | | Total value. |
|---|---|---|---|---|---|
| | Manufactured (evaporated). | In brine. | Rock salt. | Total. | |
| 1918 | 2,724,203 | 2,830,600 | 1,683,941 | 7,238,744 | $26,940,361 |
| 1919 | 2,392,290 | 2,850,639 | 1,639,973 | 6,882,902 | 27,074,694 |
| 1920 | 2,409,924 | 2,819,916 | 1,610,189 | 6,840,029 | 29,894,075 |
| 1921 | 1,931,243 | 1,577,335 | 1,472,576 | 4,981,154 | 24,557,966 |
| 1922 | 2,276,683 | 2,569,042 | 1,947,124 | 6,792,849 | 27,464,838 |

*Salt, produced in the United States, sold in 1920–1922, by States.*

| State. | 1920 | | 1921 | | 1922 | |
|---|---|---|---|---|---|---|
| | Short tons. | Value. | Short tons. | Value. | Short tons. | Value. |
| Michigan | 2,262,915 | $10,698,674 | 1,427,465 | $7,439,445 | 2,005,088 | $8,693,604 |
| New York | 1,903,101 | 7,584,921 | 1,455,014 | 6,505,041 | 1,960,867 | 7,066,409 |
| Ohio | 1,057,802 | 3,324,492 | 749,349 | 3,284,952 | 1,105,757 | 3,749,564 |
| Kansas | 783,655 | 3,839,409 | 665,968 | 3,268,661 | 759,459 | 3,849,427 |
| Louisiana | 265,085 | 1,517,414 | [a] | [a] | 336,852 | 1,657,708 |
| California | 212,008 | 1,301,426 | 193,618 | 1,043,912 | 257,790 | 1,211,197 |
| Texas | 91,103 | 667,835 | [a] | [a] | [a] | [a] |
| Utah | 75,259 | 546,186 | 68,874 | 491,354 | 81,909 | 387,093 |
| West Virginia | 29,802 | 348,556 | 27,964 | 320,537 | 25,188 | 283,257 |
| Porto Rico | | | 7,418 | 24,908 | [a] | [a] |
| New Mexico | [a] | [a] | [a] | [a] | 718 | 5,747 |
| Idaho | [a] | [a] | | | 21 | 240 |
| Undistributed [b] | 159,299 | 65,162 | 385,484 | 2,179,156 | 259,200 | 560,592 |
| | 6,840,029 | 29,894,075 | 4,981,154 | 24,557,966 | 6,792,849 | 27,464,838 |

[a] Included under "Undistributed."
[b] 1920: Hawaii, Idaho, Nevada, New Mexico, and Virginia; 1921: Hawaii, Louisiana, New Mexico, Texas, and Virginia; 1922: Porto Rico, Texas, and Virginia.

## IMPORTS AND EXPORTS.

*Salt imported for consumption in the United States, 1917–1922.*

| Year. | Short tons. | Value. | Year. | Short tons. | Value. |
|---|---|---|---|---|---|
| 1917 | 64,922 | $280,135 | 1920 | 137,654 | $676,499 |
| 1918 | 40,290 | 281,468 | 1921 | 93,095 | 531,031 |
| 1919 | 59,514 | 242,704 | 1922 | 111,710 | 517,334 |

*Salt exported from the United States, 1917–1922.*

| Year. | Short tons. | Value | Year. | Short tons. | Value. |
|---|---|---|---|---|---|
| 1917 | 113,993 | $1,000,773 | 1920 | 139,272 | $1,901,593 |
| 1918 | 136,783 | 1,677,577 | 1921 | 109,563 | 1,415,471 |
| 1919 | 119,416 | 1,396,625 | 1922 | 134,989 | 1,429,172 |

## SAND AND GRAVEL.

### PRODUCTION.

*Sand and gravel, produced in the United States, sold in 1918–1922.*

| Year. | Glass sand. | | Molding sand. | | Building sand. | |
|---|---|---|---|---|---|---|
| | Short tons. | Value. | Short tons. | Value. | Short tons. | Value. |
| 1918 | 2,172,887 | $4,209,728 | 4,910,178 | $5,121,865 | 19,686,885 | $9,772,556 |
| 1919 | 1,827,409 | 3,593,371 | 3,774,612 | 4,153,990 | 21,969,736 | 12,296,664 |
| 1920 | 2,165,926 | 4,748,690 | 5,128,075 | 7,504,759 | 26,539,365 | 17,956,635 |
| 1921 | 1,280,359 | 2,314,314 | 1,906,977 | 2,451,966 | 24,565,605 | 16,053,413 |
| 1922 | 1,768,549 | 2,866,366 | 3,839,116 | 4,478,405 | 29,375,466 | 17,574,579 |

| Year. | Other sand. | | Gravel. | | Total. | |
|---|---|---|---|---|---|---|
| | Short tons. | Value. | Short tons. | Value. | Short tons. | Value. |
| 1918 | 6,349,870 | $5,259,620 | 28,704,606 | $13,563,310 | 61,824,426 | $37,927,079 |
| 1919 | 8,397,979 | 6,345,654 | 34,606,671 | 19,561,877 | 70,576,407 | 45,951,556 |
| 1920 | 9,942,776 | 8,988,530 | 38,265,246 | 26,462,991 | 82,041,388 | 65,661,605 |
| 1921 | 10,542,013 | 8,230,257 | 41,550,054 | 27,434,295 | 79,845,008 | 56,484,245 |
| 1922 | 14,711,792 | 10,550,570 | 45,172,123 | 29,147,744 | 94,867,046 | 64,617,664 |

### IMPORTS AND EXPORTS.

*Sand and gravel imported for consumption in the United States, 1917–1922.*

| Year. | Short tons. | Value. | Year. | Short tons. | Value. |
|---|---|---|---|---|---|
| 1917 | [a] | $142,586 | 1920 | 1,226,684 | $912,282 |
| 1918 | [a] | 91,465 | 1921 | 906,905 | 771,734 |
| 1919 | 597,481 | 126,586 | 1922 | [b] 451,943 | [b] 238,386 |

[a] Quantities not recorded prior to July, 1918. During last six months of 1918, the imports were 284,036 tons, valued at $46,910.
[b] Includes 65,848 tons of gravel, valued at $27,434, and 1,290 tons of glass sand, valued at $1,112, imported after new tariff went into effect, Sept. 22. Not separately shown prior to that time.

*Sand and gravel exported from the United States, 1917–1922.*

| | | | |
|---|---|---|---|
| 1917 | $494,251 | 1920 | $669,945 |
| 1918 | 619,414 | 1921 | 379,982 |
| 1919 | 382,070 | 1922 | [a] 400,199 |

[a] Represents value of 356,520 short tons. Quantities not recorded prior to 1922.

## SAND-LIME BRICK.

### PRODUCTION.

*Sand-lime brick, produced in the United States, sold in 1917–1921.*[a]

| Year. | Number of operators. | Thousands. | Value. | Year. | Number of operators. | Thousands. | Value. |
|---|---|---|---|---|---|---|---|
| 1917 | 47 | 187,546 | $1,420,330 | 1920 | 37 | 169,761 | $2,490,283 |
| 1918 | 42 | 98,399 | 883,929 | 1921 [b] | 27 | 93,105 | 1,216,077 |
| 1919 | 35 | 146,947 | 1,705,163 | | | | |

[a] Canvass discontinued by Geological Survey after 1920. No canvass for 1922.
[b] According to Bureau of the Census.

### IMPORTS AND EXPORTS.

Imports and exports of sand-lime brick are not reported separately.

## SELENIUM.

### PRODUCTION.

*Selenium, produced in the United States, sold in 1917–1922.*

| Year. | Pounds. | Value. | Year. | Pounds. | Value. |
|---|---|---|---|---|---|
| 1917 | 39,630 | $70,000 | 1920 | 92,141 | $175,508 |
| 1918 | 103,694 | 206,540 | 1921 | 55,978 | 89,148 |
| 1919 | 60,025 | 125,966 | 1922 | 123,565 | 177,542 |

### IMPORTS.

*Selenium and selenium salts imported for consumption in the United States, 1917–1922.*

| | | | |
|---|---|---|---|
| 1917 | $2,236 | 1920 | |
| 1918 | | 1921 | $2,099 |
| 1919 | 25,866 | 1922 | 2,530 |

## SILICA.

*Quartz, produced in the United States, sold in 1918–1922.*

| Year. | Crude. | | Ground. | | Total. | |
|---|---|---|---|---|---|---|
| | Short tons. | Value. | Short tons. | Value. | Short tons. | Value. |
| 1918 | 61,008 | $121,888 | 10,732 | $137,442 | 71,740 | $259,330 |
| 1919 | 51,774 | 135,187 | 11,558 | 238,384 | 63,332 | 373,571 |
| 1920 | 59,423 | 142,397 | 8,767 | 177,953 | 68,190 | 320,350 |
| 1921 | 8,570 | 39,660 | 2,682 | 45,297 | 11,252 | 84,957 |
| 1922 | 5,085 | 23,093 | 5,568 | 78,254 | 10,653 | 101,347 |

*Silica sold for pottery, paints, fillers, polishers, abrasives, and other uses in the United States, 1920–1922.*

| Material. | 1920 | | 1921 | | 1922 | |
|---|---|---|---|---|---|---|
| | Short tons. | Value. | Short tons. | Value. | Short tons. | Value. |
| Quartz (vein quartz, pegmatite, and quartzite) | 68,190 | $320,350 | 11,252 | $84,957 | 10,653 | $101,347 |
| Sand and sandstone [a] | 158,395 | 1,183,014 | 105,887 | 802,450 | 163,295 | 1,061,057 |
| Tripoli (ground and otherwise prepared) | 40,233 | 569,677 | 12,340 | 213,013 | 30,205 | 316,728 |
| Diatomaceous earth | 61,922 | 1,079,693 | [b] 55,134 | [b] 682,616 | 44,761 | 386,669 |
| | 328,740 | 3,152,734 | 184,613 | 1,783,036 | 248,914 | 1,865,801 |

[a] Includes only finely ground material. Figures probably incomplete.
[b] Partly estimated.

### IMPORTS AND EXPORTS.

Imports of crude silica were not recorded prior to September 22, 1922, but from that date to the end of the year 1 ton, valued at $45, was imported. The Bureau of Foreign and Domestic Commerce records imports of "flint, flints, and flint stones, unground," from several countries. These imports are partly flint pebbles for use in grinding mills and partly material for uses such as are listed above. The figures can not be accurately separated.

*Flint, flints, and flint stones, unground imported for consumption in the United States, 1917–1922.*

| Year. | Short tons. | Value. | Year. | Short tons. | Value. |
|---|---|---|---|---|---|
| 1917 | (a) | $197,156 | 1920 | 26,636 | $338,630 |
| 1918 | (a) | 127,808 | 1921 | 10,084 | 116,157 |
| 1919 | 19,798 | 250,696 | 1922 | 16,040 | 145,805 |

[a] Quantities not recorded prior to July, 1918. During last six months of 1918 the imports were 5,224 tons, valued at $55,440.

No exports of silica are reported.

## SILICA BRICK.

*Silica brick, produced in the United States, sold in 1917–1922.*[a]

| Year. | Thousands. | Value. | Year. | Thousands. | Value. |
|---|---|---|---|---|---|
| 1917 | 327,030 | $15,510,595 | 1920 | 250,582 | $15,076,821 |
| 1918 | 336,562 | 19,987,803 | 1921 [b] | 104,990 | 5,220,640 |
| 1919 | 211,420 | 10,914,898 | 1922 [b] | 186,547 | 7,533,409 |

[a] Canvass discontinued by the Geological Survey after 1920.
[b] According to Bureau of the Census.

Imports and exports of silica brick are not reported separately.

## SILVER.

[See under Gold and silver.]

## SLATE.

### PRODUCTION.

*Slate, produced in the United States, sold in 1918–1922, by uses.*

| Year. | Roofing slate. | | Mill stock. | | Slate for other uses.[a] | Total value. |
|---|---|---|---|---|---|---|
| | Squares (100 sq. ft.). | Value. | Square feet. | Value. | | |
| 1918 | 379,817 | $2,219,131 | 7,204,000 | $1,853,603 | $768,386 | $4,841,120 |
| 1919 | 454,337 | 3,085,957 | 7,466,000 | 1,782,793 | 1,161,898 | 6,030,648 |
| 1920 | 396,230 | 3,524,658 | 9,910,000 | 3,147,281 | 2,054,503 | 8,726,442 |
| 1921 | 348,085 | 3,197,745 | 8,970,000 | 2,719,723 | 1,404,538 | 7,322,006 |
| 1922 | 479,243 | 4,069,761 | 9,276,800 | 2,899,195 | 2,207,828 | 9,176,784 |

[a] Chiefly slate granules.

*Value of slate sold in United States, 1918–1922, by States.*

| State. | 1918 | 1919 | 1920 | 1921 | 1922 |
|---|---|---|---|---|---|
| Maine | $287,891 | $279,274 | $450,561 | $409,303 | $464,713 |
| Maryland | 42,113 | 71,593 | 80,789 | [a] | [a] |
| New York | 323,558 | 450,379 | 911,293 | 516,956 | 642,972 |
| Pennsylvania | 2,304,647 | 2,885,072 | 3,850,267 | 3,595,386 | 4,324,294 |
| Utah | 175 | 400 | | | |
| Vermont | 1,769,987 | 2,143,648 | 3,182,477 | 2,346,978 | 2,907,858 |
| Virginia | 109,723 | 200,282 | 251,055 | 212,943 | [b] 312,652 |
| Undistributed [c] | 3,026 | | | 240,440 | [d] 524,295 |
| | 4,841,120 | 6,030,648 | 8,726,442 | 7,322,006 | 9,176,784 |

[a] Included under "Undistributed."
[b] Exclusive of value of granules, which is included under "Undistributed."
[c] 1918: California, New Jersey, and Tennessee; 1921 and 1922: Georgia, Maryland, New Jersey, and Tennessee.
[d] Includes also value of granules for Virginia.

*Slate sold in the United States, 1921 and 1922, by uses.*

| Use. | 1921 | | 1922 | |
|---|---|---|---|---|
| | Quantity. | Value. | Quantity. | Value. |
| Roofing—squares | 348,085 | $3,197,745 | 479,243 | $4,069,761 |
| Approximate equivalent in short tons | 117,500 | | 161,700 | |
| Electrical—square feet | 1,173,653 | 927,951 | 1,363,300 | 996,322 |
| Approximate equivalent in short tons | 8,400 | | 9,700 | |
| Structural and sanitary—square feet | 1,706,321 | 642,532 | 2,131,800 | 750,653 |
| Approximate equivalent in short tons | 12,300 | | 15,300 | |
| Grave vaults and covers—square feet | 552,592 | 121,967 | 400,100 | 87,763 |
| Approximate equivalent in short tons | 8,000 | | 5,700 | |
| Blackboards and bulletin boards—square feet | 3,154,201 | 791,241 | 3,518,700 | 880,985 |
| Approximate equivalent in short tons | 22,600 | | 25,100 | |
| Billiard table tops—square feet | 462,920 | 179,862 | 383,900 | 141,445 |
| Approximate equivalent in short tons | 3,300 | | 2,700 | |
| School slates—pieces | 3,591,376 | 56,170 | 2,766,600 | 42,027 |
| Approximate equivalent in square feet | 1,921,000 | | 1,479,000 | |
| Approximate equivalent in short tons | 2,500 | | 2,000 | |
| Granules—short tons | 231,770 | 1,397,886 | 379,980 | 2,177,061 |
| Other—short tons (estimated) | 5,130 | 6,652 | 5,500 | 30,767 |
| Total (quantities approximate, in short tons) | 411,500 | 7,322,006 | 607,680 | 9,176,784 |

IMPORTS AND EXPORTS.

*Value of slate imported for consumption in the United States, 1917–1922.*

| | | | |
|---|---|---|---|
| 1917 | $1,024 | 1920 | $4,512 |
| 1918 | 321 | 1921 | 2,923 |
| 1919 | 691 | 1922 | 2,753 |

*Value of roofing slate exported from the United States, 1917–1922.*

| | | | |
|---|---|---|---|
| 1917 | $27,113 | 1920 | $122,105 |
| 1918 | 65,224 | 1921 | 101,630 |
| 1919 | 55,164 | 1922 | 97,811 |

The following figures for exports of slate other than roofing were collected by the United States Geological Survey from shippers of the products named:

*Slate other than roofing exported from the United States, 1920–1922, by uses.*

| Use. | 1920 | | 1921 | | 1922 | |
|---|---|---|---|---|---|---|
| | Quantity. | Value. | Quantity. | Value. | Quantity. | Value. |
| School slates, cases [a] | 34,231 | $321,290 | 17,463 | $201,383 | 19,807 | $194,962 |
| Electrical slate, square feet | 54,038 | 44,248 | 55,459 | 53,505 | 47,219 | 41,427 |
| Blackboards, do | 32,322 | 10,726 | 155,551 | 52,598 | 104,293 | 32,217 |
| Billiard tables, do | | | 68,167 | 35,686 | 69,160 | 29,897 |
| Structural, do | (b) | (b) | 2,613 | 1,310 | 2,319 | 1,407 |
| | | 376,264 | | 344,482 | | 299,910 |

[a] Cases weigh from 130 to 165 pounds each; average is 135 pounds.
[b] Statistics not collected for 1920.

## SOAPSTONE.

[See Talc and soapstone.]

## SODIUM COMPOUNDS.

PRODUCTION.

*Domestic sodium compounds sold in the United States, 1917–1921.*[a]

| Year. | Short tons. | Value. | Year. | Short tons. | Value. |
|---|---|---|---|---|---|
| 1917 | 10,123,322 | $130,694,458 | 1920 | 9,774,289 | $138,607,384 |
| 1918 | 9,997,310 | 134,594,154 | 1921 | (b) | (b) |
| 1919 | 9,166,581 | 118,836,347 | | | |

[a] The approximate constancy in these figures from year to year is due in large part to the inclusion of sodium chloride, the fundamental sodium compound from which most of the others are made.
[b] Canvass for sodium compounds for 1921 (except for those derived from natural sources, shown in following table) conducted by Bureau of the Census. Canvass discontinued by Geological Survey after 1920. No canvass for 1922.

*Sodium salts, derived from natural sources in the United States, sold in 1921 and 1922, by varieties.*

| Salt. | 1921 | | 1922 | |
|---|---|---|---|---|
| | Short tons. | Value. | Short tons. | Value. |
| Sodium chloride (common salt): | | | | |
| Salt in brine | 1,577,335 | $1,017,080 | 2,569,042 | $1,502,435 |
| Rock salt | 1,472,576 | 6,693,923 | 1,947,124 | 7,489,644 |
| Evaporated salt | 1,931,243 | 16,846,963 | 2,276,683 | 18,472,759 |
| Sodium salts (carbonate, bicarbonate, sulphate, trona, and borax) | 25,000 | 894,000 | 45,406 | 1,415,774 |
| | 5,006,154 | 25,451,966 | 6,838,255 | 28,880,612 |

*Crude borates, produced in the United States, sold in 1917–1922.*

| Year. | Short tons. | Value. | Year. | Short tons. | Value. |
|---|---|---|---|---|---|
| 1917 | 108,875 | $3,609,632 | 1920 [a] | 120,320 | $2,173,000 |
| 1918 | 88,794 | 2,263,230 | 1921 [a] | 50,000 | 1,600,000 |
| 1919 [a] | 66,146 | 1,380,000 | 1922 [a] | 85,220 | 2,705,140 |

[a] Includes naturally occurring borax.

## IMPORTS AND EXPORTS.

*Sodium salts imported for consumption in the United States, 1921 and 1922, by varieties.*

| Salt. | 1921 | | 1922 | |
|---|---|---|---|---|
| | Pounds. | Value. | Pounds. | Value. |
| Sodium acetate | (a) | (a) | [a] 341,541 | [a] $16,744 |
| Sodium arsenate | 127,537 | $11,613 | 15,166 | 1,366 |
| Sodium benzoate | 12,121 | 12,983 | 247 | 123 |
| Sodium bicarbonate [b] | 293,060 | 4,850 | 77,458 | 1,335 |
| Sodium bromide | (a) | (a) | [a] 61,736 | [a] 85,414 |
| Sodium carbonate: | | | | |
| Soda ash | 20,344,935 | 269,720 | 3,823,933 | 56,765 |
| Monohydrate and sesquicarbonate | 71,632 | 2,220 | 15,708 | 594 |
| Sal soda | 68,779 | 1,652 | | |
| Sodium chlorate | 659,342 | 33,456 | 1,367,812 | 58,348 |
| Sodium cloride (common salt) | 186,190,200 | 531,031 | 223,420,800 | 517,334 |
| Sodium chromate and sodium bichromate | 64,236 | 5,308 | 22,731 | 1,540 |
| Sodium cyanide | 8,707,537 | 913,091 | 15,705,924 | 1,306,071 |
| Sodium ferrocyanide (yellow prussiate of sodium) | 2,510,848 | 308,395 | 4,139,012 | 639,647 |
| Sodium formate | (a) | (a) | [a] 280 | [a] 56 |
| Sodium hydrosulphite and compounds | (a) | (a) | [a] 117,694 | [a] 26,543 |
| Sodium hydroxide or caustic soda | 1,401,211 | 62,671 | 219,101 | 14,768 |
| Sodium nitrate or Chilean nitrate | 849,347,520 | 17,982,977 | 1,215,119,360 | 26,152,723 |
| Sodium nitrite | 3,174,642 | 238,083 | 1,461,528 | 58,302 |
| Sodium phosphate | 1,274,938 | 33,464 | 1,427,759 | 46,762 |
| Sodium potassium tartrate (Rochelle salt) | 388,633 | 62,141 | 502,435 | 74,290 |
| Sodium silicate | 858,146 | 26,311 | 761,479 | 18,517 |
| Sodium sulphate, crude, or salt cake, and niter cake | 369,660 | 4,643 | 1,583,677 | 13,461 |
| Sodium sulphate crystals, or Glauber's salt | 6,213,760 | 27,179 | 13,637,120 | 74,155 |
| Sodium sulphide | 5,417,921 | 153,031 | 9,166,090 | 285,176 |
| Sodium sulphite | 1,112,685 | 33,879 | 2,627,065 | 102,679 |
| Sodium tetraborate, or refined borax | 226,240 | 12,477 | 778 | 257 |
| Sodium thiosulphate, or sodium hyposulphite | 894,074 | 12,229 | 1,167,057 | 28,413 |
| | 1,089,729,597 | 20,743,404 | 1,496,783,491 | 29,581,383 |

[a] Not separately classified prior to Sept. 22, 1922, when new tariff went into effect.
[b] Or supercarbonate, or saleratus, and other salts containing 50 per cent or more of sodium bicarbonate.

*Domestic sodium salts exported from the United States, 1917–1922.*

| | | | |
|---|---|---|---|
| 1917 | $23,384,969 | 1920 | $27,191,439 |
| 1918 | 22,291,735 | 1921 | 7,921,315 |
| 1919 | 18,545,420 | 1922 | 11,759,025 |

*Domestic sodium salts exported from the United States, 1921 and 1922, by varieties.*

| Salt. | 1921 | | 1922 | |
|---|---|---|---|---|
| | Short tons. | Value. | Short tons. | Value. |
| Sodium bicarbonate | 5,852 | $307,138 | 7,928 | $341,459 |
| Sodium carbonate: | | | | |
| Soda ash | 17,521 | 850,369 | 14,814 | 678,983 |
| Sal soda | 5,177 | 204,616 | 5,732 | 186,284 |
| Sodium chloride (common salt) | 109,563 | 1,415,471 | 134,989 | 1,429,172 |
| Sodium cyanide | | | 624 | 235,224 |
| Sodium hydroxide | 24,933 | 2,041,236 | 73,370 | 5,271,528 |
| Sodium silicate | 10,395 | 247,761 | 14,565 | 302,161 |
| Sodium tetraborate (borax) | 2,031 | 269,771 | 8,825 | 875,101 |
| All other sodium salts | (a) | 2,584,953 | 48,759 | 2,439,113 |
| | | 7,921,315 | 309,606 | 11,759,025 |

[a] Figures not available prior to 1922.

*Foreign sodium salts reexported from the United States, 1918–1922.*

| Year. | Sodium chloride (common salt). | | Sodium cyanide. | | Sodium nitrate. | | All other sodium salts. |
|---|---|---|---|---|---|---|---|
| | Short tons. | Value. | Short tons. | Value. | Short tons. | Value. | |
| 1918 | 723 | $13,903 | (a) | $145 | 61,271 | $5,204,413 | $73,402 |
| 1919 | 457 | 7,992 | | | 15,314 | 1,299,563 | 388,943 |
| 1920 | 417 | 6,252 | 78 | 12,123 | 22,197 | 1,448,226 | 98,386 |
| 1921 | 651 | 5,969 | 703 | 117,258 | 37,033 | 2,011,109 | 27,224 |
| 1922 | 619 | 6,836 | 82 | 11,593 | 14,601 | 693,166 | 74,113 |

[a] 125 pounds.

## STEEL.

[See Iron ore, pig iron, and steel.]

## STONE.

### PRODUCTION.

*Stone, produced in the United States, sold in 1918–1922, by varieties.*

| Year. | Granite. | | Basalt and related rocks (trap rock). | | Sandstone. | | Marble. | |
|---|---|---|---|---|---|---|---|---|
| | Short tons. | Value. | Short tons. | Value. | Short tons. | Value. | Short tons. | Value. |
| 1918 | 3,827,400 | $14,466,423 | 6,859,200 | $7,782,280 | 2,858,100 | $4,529,298 | 305,720 | $5,496,389 |
| 1919 | 4,221,220 | 19,345,714 | 7,410,770 | 8,944,686 | 2,623,270 | 5,283,842 | 333,400 | 8,042,297 |
| 1920 | 4,700,000 | 24,954,968 | 9,219,200 | 12,260,148 | 3,343,000 | 7,310,290 | 431,500 | 11,069,585 |
| 1921 | 4,752,180 | 20,592,217 | 8,524,480 | 11,450,899 | 2,640,400 | 6,425,339 | 315,400 | 8,580,416 |
| 1922 | 5,913,120 | 21,125,869 | 10,032,900 | 12,600,611 | 3,388,130 | 7,521,044 | 427,870 | 10,534,671 |

| Year. | Limestone. | | Other stone.[a] | | Total. | |
|---|---|---|---|---|---|---|
| | Short tons. | Value. | Short tons. | Value. | Short tons. | Value. |
| 1918 | 53,868,200 | $49,453,006 | 844,740 | $973,034 | 68,563,360 | $82,700,430 |
| 1919 | 49,759,800 | 53,171,701 | 1,190,540 | 1,920,903 | 65,539,000 | 96,709,143 |
| 1920 | 59,290,000 | 75,655,260 | 1,483,360 | 2,291,769 | 78,527,000 | 133,541,960 |
| 1921 | 45,621,000 | 57,749,594 | 1,685,220 | 2,163,801 | 63,538,740 | 106,962,266 |
| 1922 | 58,928,660 | 68,397,927 | 1,520,880 | 1,886,806 | 80,211,560 | 122,066,928 |

[a] Includes mica schist, conglomerate, argillite, various light volcanic rocks, serpentine not used as marble, and such other stone as can not be properly classed in any of the main groups.

*Stone sold in the United States in 1921 and 1922, by uses.*

| Use. | 1921 | | 1922 | |
|---|---|---|---|---|
| | Quantity. | Value. | Quantity. | Value. |
| Building stone.....cubic feet | 17,006,210 | $18,975,819 | 24,262,250 | $25,749,398 |
| Approximate equivalent in short tons | 1,368,650 | | 1,929,260 | |
| Monumental stone.....cubic feet | 2,772,000 | 10,353,105 | 2,974,920 | 10,567,110 |
| Approximate equivalent in short tons | 230,000 | | 248,270 | |
| Paving blocks.....number | 41,588,860 | 3,593,373 | 31,208,800 | 2,685,234 |
| Approximate equivalent in short tons | 453,130 | | 326,290 | |
| Curbing.....cubic feet | 2,255,770 | 1,859,926 | 2,867,800 | 2,137,193 |
| Approximate equivalent in short tons | 183,600 | | 236,030 | |
| Flagging.....cubic feet | 791,660 | 471,837 | 650,590 | 406,731 |
| Approximate equivalent in short tons | 65,100 | | 53,580 | |
| Rubble.....short tons | 445,210 | 601,208 | 632,100 | 947,680 |
| Riprap.....do | 1,813,590 | 1,694,206 | 2,048,580 | 1,768,939 |
| Crushed stone.....do | 43,202,840 | 51,717,478 | 49,763,740 | 54,130,177 |
| Furnace flux (limestone and marble).....long tons | 9,525,960 | 9,457,946 | 16,712,500 | 14,247,024 |
| Equivalent in short tons | 10,669,000 | | 18,718,000 | |
| Refractory stone [a].....short tons | 496,150 | 643,638 | 902,170 | 1,136,236 |
| Manufacturing industries (limestone and marble).....short tons | 2,883,090 | 3,801,162 | 3,586,250 | 3,414,073 |
| Other uses [b].....do | 1,728,380 | 3,792,568 | 1,767,290 | 4,877,133 |
| Total (quantities approximate, in short tons) | 63,538,740 | 106,962,266 | 80,211,560 | 122,066,928 |

[a] Ganister, mica schist, and dolomite.

[b] Chiefly agricultural limestone.

## IMPORTS AND EXPORTS.

*Stone imported for consumption in the United States, 1920–1922.*

| Kind. | 1920 | | 1921 | | 1922 | |
|---|---|---|---|---|---|---|
| | Quantity. | Value. | Quantity. | Value. | Quantity. | Value. |
| Marble: | | | | | | |
| In blocks, rough, etc.....cubic feet | 468,845 | $1,258,192 | 388,731 | $810,850 | [a] 546,400 | [a]$1,137,154 |
| Sawed.....do | 102 | 922 | [b] | 105 | 42 | 112 |
| Slabs or paving tiles.....square feet | 49,013 | 27,097 | 112,470 | 44,333 | [a] 294,549 | [a] 84,471 |
| All other manufactures | | 83,768 | | 103,273 | | [a] 196,754 |
| Mosaic cubes of marble or onyx: | | | | | | |
| Loose | | 18,221 | | 30,865 | | 25,259 |
| Attached to paper | | 63 | | 581 | | 665 |
| | | 1,388,263 | | 990,007 | | [a]1,444,415 |
| Onyx: | | | | | | |
| In blocks, rough, etc.....cubic feet | 6,395 | 36,840 | 1,010 | 4,115 | [a] 2,134 | [a] 12,357 |
| Slabs or paving tiles.....square feet | 4,200 | 4,009 | 10,470 | 3,832 | [a] 2,019 | [a] 616 |
| All other manufactures | | 2,960 | | 9,990 | | [a] 4,906 |
| | | 43,809 | | 17,937 | | [a] 17,879 |
| Granite: | | | | | | |
| Dressed | | 108,193 | | 108,219 | | 183,776 |
| Rough.....cubic feet | 43,805 | 42,162 | 32,525 | 27,258 | 72,061 | 106,121 |
| | | 150,355 | | 135,477 | | 289,897 |
| Stone (other): | | | | | | |
| Dressed | | 17,622 | | 30,419 | | 18,124 |
| Rough (monumental or building stone).....cubic feet | 110,940 | 98,327 | 53,116 | 54,181 | 63,944 | 68,416 |
| Rough (other) | | 97,199 | | 25,938 | | 57,181 |
| | | 213,148 | | 110,538 | | 143,721 |
| Grand total | | 1,795,575 | | 1,253,959 | | 1,895,912 |

[a] Onyx not separately classified after new tariff went into effect (Sept. 22, 1922), but included under "Marble."
[b] Quantity not given.

*Value of stone exported from the United States, 1918–1922.*

| Kind. | 1918 | 1919 | 1920 | 1921 | 1922 |
|---|---|---|---|---|---|
| Marble and stone, unmanufactured | $552,261 | $770,392 | $774,442 | $576,905 | $681,658 |
| All other, manufactured | 1,208,164 | 1,508,997 | 2,158,764 | 1,697,570 | 903,102 |
| | 1,760,425 | 2,279,389 | 2,933,206 | 2,274,475 | 1,584,760 |

## STRONTIUM.

### PRODUCTION.

*Domestic strontium ore sold in the United States, 1916–1918.*[a]

| Year. | Short tons. | Value. |
|---|---|---|
| 1916 | 250 | $3,650 |
| 1917 | 4,035 | 87,700 |
| 1918 | 400 | 20,000 |

[a] The Geological Survey has no record of the production of domestic strontium ore prior to 1916, and no production has been reported since 1918.

### IMPORTS AND EXPORTS.

No record of the importation of strontium ore was kept at customs offices prior to September 22, 1922, when the new tariff went into effect. From that date to the end of 1922, 1,000 pounds of strontianite and celestite, valued at $40, were imported.

*Value of strontium carbonate and strontium oxide imported for consumption in the United States, 1917–1922.*

| | | | |
|---|---|---|---|
| 1917 | $23,216 | 1920 | $15,479 |
| 1918 | 2,459 | 1921 | 4,393 |
| 1919 | 3,380 | 1922 | 2,155 |

No exports of strontium ore have been reported.

## SULPHUR.

### PRODUCTION.

*Sulphur produced and shipped in the United States, 1917–1922.*

| Year. | Produced (long tons). | Shipped. | | Year. | Produced (long tons). | Shipped. | |
|---|---|---|---|---|---|---|---|
| | | Long tons. | Approximate value. | | | Long tons. | Approximate value. |
| 1917 | 1,134,412 | 1,120,378 | $23,987,000 | 1920 | 1,255,249 | 1,517,625 | $30,000,000 |
| 1918 | 1,353,525 | 1,266,709 | 27,868,000 | 1921 | 1,879,150 | 954,344 | 17,000,000 |
| 1919 | 1,190,575 | 678,257 | 10,252,000 | 1922 | 1,830,942 | 1,343,624 | 22,000,000 |

### IMPORTS AND EXPORTS.

*Sulphur imported for consumption in the United States, 1918–1922.*

| Year. | Crude. | | Refined. | | All other.[a] | | Total. | |
|---|---|---|---|---|---|---|---|---|
| | Long tons. | Value. | Long tons. | Value. | Long tons. | Value. | Long tons. | Value. |
| 1918 | 55 | $1,692 | ---- | ---- | 27 | $7,850 | 82 | $9,542 |
| 1919 | 77 | 1,997 | (b) | $15 | 24 | 6,621 | 101 | 8,633 |
| 1920 | 44 | 1,722 | 50 | 2,530 | 42 | 22,576 | 136 | 26,828 |
| 1921 | 4 | 226 | 35 | 2,311 | 11 | 3,341 | 50 | 5,878 |
| 1922 (Jan. 1 to Sept. 21 | 130 | 4,259 | 1 | 50 | 128 | 8,240 | 259 | 12,549 |
| 1922 (Sept. 22 to Dec. 31 | (c) | (c) | (c) | (c) | (c) | (c) | 37 | 2,194 |

[a] Includes sulphur lac, flowers of sulphur, and other grades not otherwise provided for, but not pyrite.
[b] Less than 1 ton.
[c] Classes not separately shown after Sept. 22.

*Sulphur exported from the United States, 1917–1922.*

| Year. | Long tons. | Value. | Year. | Long tons. | Value. |
|---|---|---|---|---|---|
| 1917 | 152,736 | $3,500,819 | 1920 | 477,450 | $8,994,350 |
| 1918 | 131,092 | 3,626,638 | 1921 | 285,762 | 4,524,768 |
| 1919 | 224,712 | 6,325,552 | 1922 [a] | 487,969 | 7,209,357 |

[a] Classified as follows: "Sulphur or brimstone," 485,664 tons, valued at $7,095,628; "refined, sublimed, and flowers of sulphur," 2,305 tons, valued at $113,729. Classes not separately shown prior to 1922.

## TALC AND SOAPSTONE.

### PRODUCTION.

*Domestic talc and soapstone sold in the United States, 1918–1922, by classes.*

| Year. | Crude. | | Sawed and manufactured. | | | | Ground. | | Total. | |
|---|---|---|---|---|---|---|---|---|---|---|
| | | | Talc. | | Soapstone. | | | | | |
| | Short tons. | Value. | Short tons. | Value. | Short tons. | Value. | Short tons. | Value. | Short tons. | Value. |
| 1918 | 17,633 | $193,278 | 1,075 | $116,952 | 12,330 | $501,059 | 177,269 | $1,869,730 | 208,307 | $2,681,019 |
| 1919 | 15,625 | 73,437 | 921 | 147,339 | 16,504 | 530,163 | 151,793 | 1,601,736 | 184,843 | 2,352,675 |
| 1920 | 11,008 | 43,820 | 1,415 | 139,335 | 19,707 | 709,400 | 178,505 | 2,142,894 | 210,635 | 3,035,449 |
| 1921 | 2,150 | 12,911 | (a) | (a) | [a]17,423 | [a]627,826 | 102,413 | 1,115,205 | 121,986 | 1,755,942 |
| 1922 | 4,981 | 22,582 | 654 | 86,333 | 22,700 | 712,144 | 170,349 | 2,038,838 | 198,684 | 2,859,897 |

[a] Talc included under "Soapstone."

### IMPORTS AND EXPORTS.

*Talc imported for consumption in the United States, 1918–1922.*

| Year. | Crude and unground steatite and French chalk. | | Talc, steatite, and French chalk—cut, ground, or washed.[a] | | Total. | |
|---|---|---|---|---|---|---|
| | Short tons. | Value. | Short tons. | Value. | Short tons. | Value. |
| 1918 | 1,434 | $9,253 | 12,735 | $251,323 | 14,169 | $260,576 |
| 1919 | 1,641 | 10,105 | 12,961 | 248,899 | 14,602 | 259,004 |
| 1920 | 941 | 7,206 | 21,739 | 443,514 | 22,680 | 450,720 |
| 1921 | 153 | 2,279 | 11,468 | 239,469 | 11,621 | 241,748 |
| 1922 | 248 | 9,850 | 18,196 | 367,528 | 18,444 | 377,378 |

[a] Classification after Sept. 21, 1922, under new tariff, is "Manufactures (except toilet preparations) wholly or partly finished."

No material that might be classed as soapstone is imported.

Exports of "talcum and other toilet powders" in 1922 amounted to 1,821 short tons, valued at $1,397,542. Exports of talc and soapstone were not separately classified prior to 1922.

## TANTALUM.

### PRODUCTION.

The only tantalum minerals produced in the United States for several years are the lots shipped from time to time from the Black Hills of South Dakota. Shipments of columbite by A. T. Roos from pegmatites near Keystone and Hill City, S. Dak., have been as follows:

*Columbite, produced in the United States, shipped in 1918–1922.*

| Year. | Pounds. | Value. |
|---|---|---|
| 1918 | 4,500 | $2,250 |
| 1919 | 300 | 90 |
| 1920 | 4,000 | 1,450 |
| 1921 | 3,400 | 1,150 |
| 1922 | 600 | 240 |

### IMPORTS AND EXPORTS.

No tantalum or "tantalum steel-hardening ores" were imported in 1922 or 1920. In 1921, 6,785 pounds of "tantalum steel-hardening ores," valued at $1,327, and, under the heading "Tantalum," 1,229 pounds of material, valued at $788, were imported. From the value given for the "tantalum," it seems probable that this material was tantalum ore. No separate record of exports is kept.

## TELLURIUM.

Nearly all the metallic tellurium produced in 1922 was sold to manufacturers of electric equipment. Two producers, the Raritan Copper Works and the United States Smelting, Refining & Mining Co., reported a production in 1922 about 25 per cent larger than that of 1921, but the Survey is not at liberty to publish the figures. A market for the entire output of tellurium in the United States is a possibility in the development of its use in treating fuels for internal-combustion engines, particularly airplane motors. In common with many other substances, tellurium has been found to work admirably as a crystal detector in radio work.

Imports and exports of tellurium are not reported separately.

## THORIUM MINERALS.

Information regarding production of monazite sand in the United States since 1918 is not available for publication.

*Monazite sand and thorium nitrate imported for consumption in the United States, 1918–1922.*

| Year. | Monazite sand. | | Thorium nitrate. | |
|---|---|---|---|---|
| | Pounds. | Value. | Pounds. | Value. |
| 1918 | 2,994,515 | $204,661 | | |
| 1919 | 632,568 | 48,768 | 3,307 | $5,250 |
| 1920 | 1,814,185 | 141,528 | 35,640 | 43,221 |
| 1921 | 50 | 40 | 44,554 | 89,672 |
| 1922 | 3,466,844 | 210,187 | 43,254 | 42,096 |

Exports of thorium nitrate in 1922 amounted to 1,103 pounds, valued at $3,149. Data for earlier years are not separately shown.

## TIN.

### PRODUCTION.

*Tin mined in the United States (including Alaska), 1917–1922.*

[Metallic tin estimated as obtainable from concentrates produced in tin mining.]

| Year. | Short tons. | Value. | Year. | Short tons. | Value. |
|---|---|---|---|---|---|
| 1917 | 110 | $135,600 | 1920 | 22 | $22,000 |
| 1918 | 69 | 118,500 | 1921 | 4 | 2,400 |
| 1919 | 56 | 73,400 | 1922 | [a] 1 | 912 |

[a] 2,800 pounds.

*Smelter output of metallic tin in the United States, 1917–1922, in short tons.*

| | | | |
|---|---|---|---|
| 1917 | 6,065 | 1920 | 17,652 |
| 1918 | 10,284 | 1921 | 11,542 |
| 1919 | 12,236 | 1922 | 9,108 |

*World's production of tin in 1920 and 1921, in metric tons.*

[Estimated recoverable metallic tin contained in ore mined.]

| Country. | 1920 | 1921 |
|---|---|---|
| Bolivia | 29,210 | 19,750 |
| British Empire: | | |
| Australia | 4,245 | 3,038 |
| Cornwall | 3,114 | 690 |
| Federated Malay States | 35,495 | 35,043 |
| Nigeria | 5,630 | 5,110 |
| Nonfederated Malay States | 2,050 | 1,830 |
| Union of South Africa | 1,480 | 790 |
| India and other countries | 3,570 | 2,000 |
| China | 11,487 | 6,231 |
| Dutch East Indies: | | |
| Banka | 13,666 | 15,104 |
| Billiton and Singkep | 8,286 | 12,238 |
| Siam | 6,301 | 6,280 |
| Other countries | 1,230 | 1,600 |
| | 125,764 | 109,704 |

## IMPORTS AND EXPORTS.

*Metallic tin imported for consumption in the United States, 1917–1922.*

| Year. | Short tons. | Value. | Year. | Short tons. | Value. |
|---|---|---|---|---|---|
| 1917 | 72,166 | $63,860,340 | 1920 | 62,795 | $73,440,872 |
| 1918 | 71,254 | 93,144,218 | 1921 | 27,101 | 16,645,719 |
| 1919 | 44,849 | 50,890,019 | 1922 | 67,416 | 40,797,986 |

*Tin ore (concentrate) imported into the United States, 1917–1922.*

[General imports.]

| Year. | Short tons. | Value. | Year. | Short tons. | Value. |
|---|---|---|---|---|---|
| 1917 | 9,054 | $4,743,099 | 1920 | 34,148 | $18,795,162 |
| 1918 | 18,394 | 11,444,401 | 1921 | 15,340 | 5,672,861 |
| 1919 | 19,196 | 11,871,948 | 1922 | 13,804 | 5,504,434 |

Exports of tin ore are insignificant.

*Metallic tin (pigs, bars, etc.) of domestic manufacture exported from the United States, 1917–1922.*

| Year. | Short tons. | Value. | Year. | Short tons. | Value. |
|---|---|---|---|---|---|
| 1917 | 206 | $232,401 | 1920 | 706 | $770,375 |
| 1918 | 20 | 31,952 | 1921 | 1,154 | 748,077 |
| 1919 | 306 | 415,921 | 1922 | 901 | 574,792 |

## PRICES.

*Average monthly prices, in cents per pound, of Straits tin in New York, 1921 and 1922.*[a]

| Month. | 1921 | 1922 | Month. | 1921 | 1922 |
|---|---|---|---|---|---|
| January | 36.11 | 32.11 | July | 27.69 | 31.82 |
| February | 32.47 | 30.82 | August | 26.40 | 32.44 |
| March | 28.85 | 29.17 | September | 26.73 | 32.41 |
| April | 30.41 | 30.65 | October | 27.74 | 34.64 |
| May | 32.52 | 30.97 | November | 29.02 | 36.72 |
| June | 29.57 | 31.54 | December | 32.49 | 37.68 |

[a] Metal Statistics, 1923, p. 325.

*Average yearly prices, in cents per pound, of Straits tin in New York, 1917–1922.*[a]

| | | | |
|---|---|---|---|
| 1917 | 61.65 | 1920 | 50.36 |
| 1918 | 86.80 | 1921 | 30.00 |
| 1919 | 65.54 | 1922 | 32.58 |

[a] Metal Statistics, 1923, p. 325.

## TITANIUM MINERALS.

### PRODUCTION.

During 1922 the American Rutile Co. operated its quarry at Roseland, Nelson County, Va., and produced 310 short tons of rutile concentrates carrying about 95 per cent of titanium dioxide and as a by-product 600 tons of ilmenite concentrates carrying about 54 per cent. The ilmenite concentrates carry a little rutile so that they contain more than the theoretical quantity of $TiO_2$.

Buckman & Pritchard (Inc.), a subsidiary of the Titanium Pigment Co. (Inc.), with works at Niagara Falls, N. Y., worked the beach sands 4 miles south of Pablo Beach, Fla., in which ilmenite has been concentrated between high and low tide levels. The sand also contains considerable zircon, a little rutile, and a little monazite. During the year 4,581 tons of ilmenite carrying probably about 52 per cent of $TiO_2$ was shipped to Niagara Falls to be used for the manufacture of both ferrotitanium and titanium pigment.

*Titanium minerals produced in the United States, 1918–1922.*

| Year. | Rutile concentrates. | | | Ilmenite concentrates. | | |
|---|---|---|---|---|---|---|
| | Short tons. | Percentage of $TiO_2$. | Value. | Short tons. | Percentage of $TiO_2$. | Value. |
| 1918 | 261 | 95 | $39,150 | 1,644 | 53–55 | $18,600 |
| 1919 [a] | 102 | 94–96 | 20,400 | 106 | 48–50 | 2,120 |
| 1920 | 277 | 94–96 | [b] | 268 | 50 | [b] |
| 1921 | | | | | | |
| 1922 | 310 | 95 | [b] | 5,181 | 52–54 | [b] |

[a] Virginia production only; information regarding Florida not available for publication.
[b] Survey not at liberty to publish figures.

### IMPORTS AND EXPORTS.

No titanium or "titanium steel-hardening" ores have been imported since 1918. The imports of such ores during the last six months of 1918 were 1,606 pounds, valued at $221. No separate record of similar imports was kept prior to July, 1918. Imports of "titanium potassium oxalate and all compounds and mixtures containing titanium" amounted to 82,544 pounds, valued at $20,596, from September 22 to December 31, 1922. Similar imports were not separately classified prior to the new tariff. For imports of ferrotitanium see under Ferroalloys.

No separate record of exports of titanium, "titanium steel-hardening" ores, or ferrotitanium is kept.

## TRIPOLI.

[See Abrasive materials.]

## TUNGSTEN.

### PRODUCTION.

No tungsten ores were mined in the United States during either 1922 or 1921, the only years in which there has been no production since 1899.

*Concentrated tungsten ores (carrying 60 per cent of tungsten trioxide), produced in the United States, sold in 1917–1922, and average value per unit.*

| Year. | Short tons. | Value. | Average value per unit. | Year. | Short tons. | Value. | Average value per unit. |
|---|---|---|---|---|---|---|---|
| 1917 | 6,144 | $6,783,000 | $18.40 | 1920 | 216 | $101,800 | $7.86 |
| 1918 | 5,061 | 7,049,300 | 23.24 | 1921 | | | |
| 1919 | 327 | 353,900 | 18.02 | 1922 | | | |

### IMPORTS AND EXPORTS.

The law placing a duty of 45 cents a pound on the tungsten contained in ores or concentrates, equivalent to $7.14 a short ton unit, went into effect September 22, 1922, and, except for one small belated shipment, imports of ore ceased immediately.

*Tungsten-bearing ores imported for consumption in the United States, 1917–1922.*

| Year. | Short tons. | Value. | Year. | Short tons. | Value. |
|---|---|---|---|---|---|
| 1917 | 4,876 | $4,465,590 | 1920 | 1,949 | $779,593 |
| 1918 | 11,750 | 11,552,218 | 1921 | 1,614 | 276,757 |
| 1919 | 9,408 | 6,261,190 | 1922 | 1,651 | 279,190 |

For imports of tungsten and ferrotungsten see under Ferroalloys.

Although it is known that some has been shipped abroad, no record of tungsten ore exported is at hand until 1922, when "tungsten ore and concentrates (tungsten content)" were exported to the amount of 717 pounds, valued at $594.

For exports of tungsten and ferrotungsten see under Ferroalloys.

### PRICES.

Tungsten prices can be given only in a general way, for they are always more or less a matter of bargaining, and lots are sold on the same day at considerably different prices. The year began with Chinese ore carrying 67½ per cent of $WO_3$, or more, at $2 a unit in New York, and Bolivian ore of higher grade at $2.50 to $3 a unit. In March, even with the assurance of a heavy duty, the price of Chinese ore dropped to $1.80 for material that was a little off color but usable. Soon after the tariff bill became a law heavy buying began, showing that many steel makers had not covered their needs, and the price advanced to $7 for Chinese ore. By November scheelite of good quality sold for $8 a unit, and these prices remained to the end of the year. Prices abroad were less than $3 a unit to the end of the year.

## URANIUM AND VANADIUM ORES.

### PRODUCTION.

Four companies produced radium in 1922, and four mines were operated. The radium produced during the year amounted to 24.189 grams of radium in salts and was isolated by the Standard Chemical Co., of Pittsburgh, Pa.; the United States Radium Corporation, of New York City; the Radium Corporation of Colorado, of Denver, Colo.; and the Keystone Metals Reduction Co., of Pittsburgh. The production was only about two-thirds of the 35.693 grams isolated in 1921. In 1920 the quantity was 32.539 grams, and in 1919 it was 28.648 grams. Only 929 tons of dry ore was mined and shipped during 1922. It contained 27.35 tons of $U_3O_8$ (23.2 tons of uranium), 7.015 grams of radium, and 46.27 tons of $V_2O_5$ (25.9 tons of vanadium) and was valued at $166,016.

The output of uranium and vanadium ores in 1921 was estimated at 8,540 short tons, containing 109 tons of uranium (128.5 tons of $U_3O_8$), 201.5 tons of vanadium (359.9 tons of $V_2O_5$), and about 33 grams of radium. The approximate value, as ore, was probably about $876,000. About 35.693 grams of radium (mostly as sulphate) was isolated during the year. The output of uranium and vanadium ores in 1920 was estimated at 35,076 short tons containing 143.5 tons of uranium (169.1 tons of $U_3O_8$), 526.7 tons of vanadium (909.8 tons of $V_2O_5$), and about 43.4 grams of radium. The approximate value, as ore, was probably about $2,401,000. About 32.539 grams of radium in various salts was isolated during the year. Any value given to the output must be arbitrary and open to question, for the larger part of the uranium ores was produced by companies that themselves used the ores. Neither in 1922 nor in 1921 were vanadium ores as such mined in this country, all the vanadium being a by-product of carnotite mined for radium.

More than half of the world's vanadium has come from Peru, and most of the remainder from southwestern Colorado and southeastern Utah. As mining in the United States has nearly ceased, the Peruvian ores have become preponderant.

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*Approximate world's production of vanadium, 1918–1922.*

| Year. | Shipments of ore from countries other than United States. | | | United States vanadium content of ore and concentrates produced (short tons). | Total (short tons). |
|---|---|---|---|---|---|
| | Short tons. | Percentage of $V_2O_5$. | Vanadium contained (short tons). | | |
| 1918 | [a] 2,407 | 19.10 | 257 | 276 | 533 |
| 1919 | [a] 3,249 | 30.41 | 553 | 284 | 837 |
| 1920 | [a] 11,158 | 20.43 | 1,277 | 527 | 1,804 |
| 1921 | [a] 1,958 | 20.23 | 222 | 202 | 424 |
| 1922 | 782 | 17.18 | 78 | 26 | 104 |

[a] Peruvian ore only. During these years a little vanadium was produced in other countries, but the quantity was negligible.

## IMPORTS AND EXPORTS.

*Value of uranium salts and oxide, including some radium salts, imported for consumption in the United States, 1917–1922.*

| | | | |
|---|---|---|---|
| 1917 | $2,930 | 1920 | $3 |
| 1918 | 274 | 1921 | 8,552 |
| 1919 | 12,960 | 1922 | 28,685 |

*Vanadium ore (steel-hardening) imported for consumption in the United States, 1918–1922.*

| Year. | Pounds. | Value. | Year. | Pounds. | Value. |
|---|---|---|---|---|---|
| 1918—July to December [a] | 1,772,215 | $5,333 | 1921 | 10,307,540 | $543,061 |
| 1919 | 6,026,005 | 67,846 | 1922 | 611,170 | 86,776 |
| 1920 | 20,673,296 | 1,080,935 | | | |

[a] Not separately classified prior to July, 1918.

*Uranium-radium ore (steel-hardening) imported for consumption in the United States, 1918–1922.*

| Year. | Pounds. | Value. | Year. | Pounds. | Value. |
|---|---|---|---|---|---|
| 1918—July to December [a] | 157 | $4,840 | 1921 | 250 | $446 |
| 1919 | | | 1922 | | |
| 1920 | 396 | 1,110 | | | |

[a] Not separately classified prior to July, 1918.

For imports of ferrovanadium see under Ferroalloys.

No separate record is kept of vanadium exports. For exports of ferrovanadium see under Ferroalloys.

## PRICES.

The price of vanadium in ferrovanadium at the beginning of 1922 was nominally $5 to $6 a pound, depending on the silicon and other impurities present. The price gradually dropped to $3.50 a pound and remained nominally at that point, though some was probably bought as low as $2.50 a pound.

## ZINC.

### SUPPLY.

*Supplies of primary zinc in the United States, 1918–1922, in short tons.*

| | 1918 | 1919 | 1920 | 1921 | 1922 |
|---|---|---|---|---|---|
| Supply: | | | | | |
| Stock, Jan. 1— | | | | | |
| In bonded warehouses | 32 | | | | 131 |
| At smelters | 53,689 | 41,241 | 36,793 | 71,037 | 70,321 |
| Production | 517,927 | 465,743 | 463,377 | 200,500 | 354,277 |
| Imports— | | | | | |
| Foreign | 35 | 70 | 15 | 6,739 | 52 |
| Domestic returned | | | 8,162 | 731 | |
| Total available | 571,683 | 507,054 | 508,347 | 279,007 | 424,781 |
| Withdrawn: | | | | | |
| Exports, foreign, from warehouse | 20,069 | 12,256 | 28,132 | 1,256 | 3,471 |
| Exports, foreign, under drawback | 6,337 | 4,533 | 237 | 130 | 1,298 |
| Exports, domestic | 80,244 | 129,508 | 85,898 | 3,569 | 30,032 |
| Stock, Dec. 31— | | | | | |
| In bonded warehouses | | | | 131 | 80 |
| At smelters | 41,241 | 36,793 | 71,037 | 70,321 | 16,810 |
| Total withdrawn | 147,891 | 183,090 | 185,304 | 75,407 | 51,691 |
| Apparent consumption | 423,792 | 323,964 | 323,043 | 203,600 | 373,090 |

### PRODUCTION.

*Primary zinc produced in the United States from domestic ores, 1917–1922*

| Year. | Short tons. | Value. | Year. | Short tons. | Value. |
|---|---|---|---|---|---|
| 1917 | 584,597 | $119,258,000 | 1920 | 450,045 | $72,907,000 |
| 1918 | 492,405 | 89,618,000 | 1921 | 198,232 | 19,823,000 |
| 1919 | 452,272 | 66,032,000 | 1922 | 353,274 | 40,273,000 |

*Primary zinc produced in the United States, 1918–1922, by sources of ore, in short tons.*

| Source. | 1918 | 1919 | 1920 | 1921 | 1922 |
|---|---|---|---|---|---|
| United States | 492,405 | 452,272 | 450,045 | 198,232 | 353,274 |
| Foreign: | | | | | |
| Canada | 8,700 | 4,007 | 1,583 | 521 | 55 |
| Mexico | 14,043 | 8,083 | 8,978 | 1,614 | 948 |
| South America | 886 | 751 | 536 | | |
| Europe | 113 | | | | |
| Australia | 1,780 | 630 | 2,235 | 133 | |
| Total foreign | 25,522 | 13,471 | 13,332 | 2,268 | 1,003 |
| Grand total | 517,927 | 465,743 | 463,377 | 200,500 | 354,277 |

*Primary zinc produced in the United States, 1918–1922, by localities in which smelted, in short tons.*

| Location of smelter. | 1918 | 1919 | 1920 | 1921 | 1922 |
|---|---|---|---|---|---|
| Arkansas | 26,753 | 31,437 | 31,481 | 15,278 | 13,627 |
| Illinois | 141,844 | 118,458 | 109,056 | 48,865 | 76,266 |
| Kansas | 29,149 | 43,942 | 41,044 | 16,573 | 24,167 |
| Oklahoma | 139,066 | 121,988 | 110,500 | 41,244 | 74,537 |
| Pennsylvania | 77,342 | 67,521 | 74,234 | 36,378 | 57,319 |
| Other States | 103,773 | 82,397 | 97,062 | 42,162 | 108,361 |
| | 517,927 | 465,743 | 463,377 | 200,500 | 354,277 |

*Secondary zinc recovered as metal in the United States, 1918–1922, in short tons.*

| | 1918 | 1919 | 1920 | 1921 | 1922 |
|---|---|---|---|---|---|
| Secondary zinc, redistilled | 9,918 | 19,748 | 21,371 | 17,573 | 32,988 |
| Secondary zinc, remelted | 17,190 | 20,162 | 21,479 | 16,260 | 36,326 |
| Secondary zinc in alloys, excluding old brass remelted | 11,082 | 6,062 | 7,650 | 5,840 | 10,250 |
| Secondary zinc in remelted brass | 82,400 | 62,400 | 65,000 | 38,627 | 60,280 |

## IMPORTS AND EXPORTS.

*Zinc imported for consumption in the United States, 1918–1922.*

| Year. | Blocks or pigs. | | Sheets. | | Old. | | Zinc dust. | | Manufactures. | Total value. |
|---|---|---|---|---|---|---|---|---|---|---|
| | Short tons. | Value. | Short tons. | Value. | Short tons. | Value. | Short tons. | Value. | | |
| 1918 | 11 | $2,897 | (a) | $29 | 24 | $2,056 | 16 | $3,552 | $331 | $8,865 |
| 1919 | 32 | 2,284 | 1 | 249 | 37 | 2,216 | 52 | 5,753 | 1,258 | 11,760 |
| 1920 | (a) | 17 | 4 | 614 | 14 | 1,065 | 17 | 6,207 | 1,746 | 9,649 |
| 1921 | 6,598 | 559,870 | 6,688 | 496,445 | 6 | 341 | 42 | 1,121 | 8,290 | 1,066,067 |
| 1922 | 40 | 3,327 | 416 | 59,037 | 46 | 2,403 | 79 | 5,614 | 9,517 | 79,898 |

[a] Less than 1 ton.

*Zinc ore imported into the United States, 1921 and 1922, by countries.*

[General imports.]

| Country. | 1921 | | | 1922 | | |
|---|---|---|---|---|---|---|
| | Ore (short tons). | Zinc content (short tons). | Value. | Ore (short tons). | Zinc content (short tons). | Value. |
| Canada | 1,471 | 554 | $14,453 | (a) | 235 | $8,005 |
| Mexico | 6,050 | 2,147 | 43,414 | (a) | 1,665 | 10,971 |
| Other countries | 18 | 4 | 833 | (a) | 29 | 2,988 |
| | 7,539 | 2,705 | 58,700 | (a) | 1,929 | 21,964 |

[a] Figures not available.

*Domestic zinc ore and domestic manufactures of zinc exported from the United States, 1918–1922.*

| Year. | Zinc ore. | | Pigs or slabs. | | Plates and sheets. | | Zinc dross. | | All other manufactures.[a] | Total value. |
|---|---|---|---|---|---|---|---|---|---|---|
| | Short tons. | Value. | Short tons. | Value. | Short tons. | Value. | Short tons. | Value. | | |
| 1918 | 62 | $2,480 | 66,369 | $12,469,622 | 13,875 | $4,566,756 | 15,816 | $2,238,913 | $722,671 | $20,000,442 |
| 1919 | ------ | ------ | 109,746 | 17,524,153 | 19,762 | 5,212,002 | 5,123 | 739,295 | 538,133 | 24,013,583 |
| 1920 | ------ | ------ | 74,046 | 12,495,144 | 11,852 | 2,832,993 | 2,445 | 316,637 | 1,057,676 | 16,702,450 |
| 1921 | ------ | ------ | 1,753 | 204,984 | 1,816 | 425,618 | 510 | 45,340 | 391,996 | 1,067,938 |
| 1922 | 1,695 | 33,592 | 26,815 | 2,994,625 | 3,217 | 574,491 | 8,412 | 662,080 | 122,087 | 4,386,875 |

[a] Not including brass.

*Zinc exported from the United States in 1921 and 1922, by destinations.*

| Destination. | Domestic. | | | | Foreign (slabs). | |
|---|---|---|---|---|---|---|
| | Slabs. | | Sheets. | | | |
| | Short tons. | Value. | Short tons. | Value. | Short tons. | Value. |
| **1921.** | | | | | | |
| Canada | 106 | $10,893 | 808 | $159,268 | 136 | $11,210 |
| Mexico | 206 | 24,106 | 313 | 69,380 | | |
| France | 280 | 32,007 | | | | |
| Great Britain | | | 178 | 50,105 | | |
| Italy | | | 23 | 5,308 | | |
| Japan | 819 | 89,241 | 96 | 29,592 | 1,120 | 89,467 |
| Other countries | 342 | 48,737 | 398 | 111,965 | | |
| | 1,753 | 204,984 | 1,816 | 425,618 | 1,256 | 100,677 |
| **1922.** | | | | | | |
| Canada | 464 | 52,674 | 1,282 | 202,149 | 50 | 5,950 |
| Mexico | 415 | 49,685 | 375 | 58,977 | 119 | 15,845 |
| France | 8,282 | 938,978 | 75 | 13,674 | 784 | 82,306 |
| Great Britain | 7,342 | 793,207 | 593 | 133,405 | 2,021 | 274,335 |
| Italy | 319 | 33,101 | 2 | 690 | 196 | 19,665 |
| Japan | 6,060 | 638,867 | 255 | 31,289 | 224 | 22,175 |
| Other countries | 3,933 | 488,113 | 635 | 134,307 | 77 | 8,846 |
| | 26,815 | 2,994,625 | 3,217 | 574,491 | 3,471 | 429,122 |

PRICES.

[See statement on page 14A.]

## ZINC RESIDUUM.

[See Manganiferous zinc residuum.]

## ZIRCONIUM MINERALS.

PRODUCTION.

The Geological Survey has been advised that 20,100 pounds of zircon was shipped from Florida in 1922. The value of this zircon is estimated by the Survey as $1,150. No production in the United States was reported to the Geological Survey from 1912 to 1921, inclusive. Brazil is the world's main producer of zirconium ores. The zirconium minerals produced in Brazil and exported consist of the silicate, zircon, and the oxide, baddeleyite.

*Zirconium minerals, produced in Brazil, exported in 1917–1922.*

| Year. | Metric tons. | Equivalent in short tons. | Year. | Metric tons. | Equivalent in short tons. |
|---|---|---|---|---|---|
| 1917 | 483 | 532 | 1920 | 542 | 597 |
| 1918 | 2,141 | 2,360 | 1921 | 122 | 134 |
| 1919 | 208 | 229 | 1922 | 332 | 366 |

## IMPORTS.

*Zirconium ores (steel-hardening) imported for consumption in the United States, 1918–1922.*

| Year. | Pounds. | Value. | Year. | Pounds. | Value. |
|---|---|---|---|---|---|
| 1918—July to December [a] | 3,216,659 | $77,250 | 1921 | 131,016 | $3,003 |
| 1919 | 11,023 | 332 | 1922 | 67,037 | 4,072 |
| 1920 | | | | | |

[a] Not separately classified prior to July, 1918.

## STATE TABLES.

*Value of mineral production in the United States, 1919 to 1922, by States.*[a]

| State. | 1919 | 1920 | 1921 | 1922 |
|---|---|---|---|---|
| Alabama | $65,540,376 | $86,289,575 | $52,269,451 | $61,723,268 |
| Alaska | 19,616,909 | 23,396,114 | 17,041,057 | 19,506,610 |
| Arizona | 112,512,239 | 116,383,335 | 30,818,363 | 63,737,720 |
| Arkansas | 10,709,213 | 17,813,328 | 22,515,412 | 31,418,633 |
| California | 213,823,488 | 269,404,686 | 297,025,679 | 283,411,997 |
| Colorado | 59,953,279 | 76,037,896 | 54,045,056 | 54,806,277 |
| Connecticut | 5,152,124 | 6,326,326 | 4,219,457 | 5,346,295 |
| Delaware | 390,706 | 359,833 | 379,785 | 428,314 |
| District of Columbia | 105,623 | 369,534 | 411,745 | 869,132 |
| Florida | 10,513,495 | 22,923,780 | 12,597,948 | 10,907,718 |
| Georgia | 9,429,972 | 12,178,695 | 8,650,003 | 11,120,018 |
| Idaho | 19,044,567 | 32,449,783 | 16,502,273 | 18,495,628 |
| Illinois | 213,701,212 | 373,926,540 | 254,019,136 | 244,617,561 |
| Indiana | 82,270,784 | 146,736,294 | 97,700,676 | 108,394,095 |
| Iowa | 37,882,183 | 57,250,480 | 35,639,505 | 36,205,251 |
| Kansas | 120,759,783 | 198,097,758 | 113,098,346 | 103,884,561 |
| Kentucky | 110,305,840 | 195,920,036 | 114,404,662 | 158,701,496 |
| Louisiana | 38,851,509 | 138,745,725 | 61,061,974 | 75,519,328 |
| Maine | 4,073,870 | 5,428,086 | 4,392,039 | 5,588,140 |
| Maryland | 18,345,024 | 30,944,378 | 16,083,965 | 14,905,227 |
| Massachusetts | 10,070,543 | 12,411,708 | 9,835,107 | 11,004,523 |
| Michigan | 122,973,774 | 166,338,818 | 69,452,819 | 101,430,981 |
| Minnesota | 131,529,797 | 177,589,967 | 72,609,973 | 111,617,448 |
| Mississippi | 1,628,031 | 2,201,246 | 1,954,353 | 1,600,393 |
| Missouri | 61,862,232 | 90,994,479 | 56,375,543 | 62,402,642 |
| Montana | 73,630,824 | 85,885,403 | 30,161,734 | 59,400,591 |
| Nebraska | 7,658,424 | 7,168,424 | 2,366,287 | 2,996,587 |
| Nevada | 24,457,735 | 25,648,961 | 14,038,071 | 18,374,023 |
| New Hampshire | 2,294,959 | 2,986,485 | 2,234,007 | 2,283,119 |
| New Jersey | 56,898,033 | 72,335,207 | 47,429,290 | 62,396,379 |
| New Mexico | 22,679,960 | 27,883,565 | 13,227,268 | 18,038,022 |
| New York | 56,779,564 | 78,431,317 | 62,502,458 | 73,527,880 |
| North Carolina | 6,223,953 | 7,760,482 | 5,456,479 | 7,268,381 |
| North Dakota | 2,413,025 | 3,078,548 | 2,500,349 | 3,693,095 |
| Ohio | 214,829,888 | 355,844,499 | 223,533,658 | 236,808,638 |
| Oklahoma | 291,078,174 | 493,320,359 | 269,882,786 | 369,069,612 |
| Oregon | 3,962,822 | 5,496,253 | 5,199,803 | 5,489,956 |
| Pennsylvania | 918,048,917 | 1,314,332,585 | 944,688,650 | 823,148,222 |
| Rhode Island | 853,981 | 1,175,653 | 922,765 | 770,966 |
| South Carolina | 2,370,916 | 2,825,479 | 1,754,491 | 2,414,346 |
| South Dakota | 5,842,704 | 5,950,878 | 7,498,656 | 7,278,934 |
| Tennessee | 37,134,899 | 55,023,232 | 33,754,823 | 35,146,266 |
| Texas | 190,563,015 | 371,250,979 | 212,302,907 | 249,604,173 |
| Utah | 64,165,525 | 76,536,657 | 40,595,872 | 60,697,116 |
| Vermont | 11,728,052 | 15,008,894 | 10,650,213 | 9,576,636 |
| Virginia | 36,799,407 | 60,161,247 | 32,810,842 | 38,551,479 |
| Washington | 18,267,938 | 26,677,191 | 17,605,878 | 19,725,303 |
| West Virginia | 298,168,194 | 547,872,937 | 316,180,647 | 358,772,116 |
| Wisconsin | 18,772,601 | 19,630,114 | 9,990,961 | 13,822,883 |
| Wyoming | 41,097,209 | 83,034,397 | 51,365,150 | 58,529,284 |

[a] In this table iron ore, not pig iron, is taken as the basis of valuation of iron, and in the case of other metals mine production (recoverable content of metals) is the basis.

*Mineral production of Alabama in 1921 and 1922.*

| Product. | 1921 | | 1922 | |
|---|---|---|---|---|
| | Quantity. | Value. | Quantity. | Value. |
| Barytes short tons | [a] | [a] | [a] | [a] |
| Bauxite long tons | [a] | [a] | [a] | [a] |
| Cement barrels | [b] 1,714,286 | [b] $3,466,223 | [b] 2,324,116 | [b] $4,135,684 |
| Chert short tons | | | 63,423 | 20,209 |
| Clay products | | [c] 2,266,704 | | [c] 2,798,255 |
| Clay, raw short tons | 46,852 | [d] 48,736 | 60,523 | [d] 49,765 |
| Coal do | 12,568,899 | 38,713,000 | 18,324,740 | 42,856,000 |
| Coke do | 2,534,039 | [d] 12,256,085 | 3,799,865 | [d] 14,708,245 |
| Ferroalloys long tons | [a d] | [a d] | [a d] | [a d] |
| Fuller's earth short tons | [a] | [a] | [a] | [a] |
| Graphite, crystalline pounds | [a] | [a] | 577,940 | 25,777 |
| Iron ore long tons | 2,835,761 | 5,058,161 | 5,294,520 | 8,791,069 |
| Iron, pig do | 1,241,227 | [d] 30,195,978 | 2,223,159 | [d] 42,883,424 |
| Lime short tons | 109,256 | 847,629 | 168,135 | 979,331 |
| Manganiferous ore long tons | | | 475 | 1,900 |
| Mica: | | | | |
| Scrap short tons | | | [a] | [a] |
| Sheet pounds | | | [a] | [a] |
| Millstones | | [a] | | [a] |
| Mineral waters gallons sold | 892 | 690 | 5,389 | 875 |
| Sand and gravel short tons | 774,616 | 381,425 | 848,743 | 346,920 |
| Stone do | 576,610 | 1,304,965 | [e] 863,910 | [e] 828,435 |
| Miscellaneous [f] | | 1,787,022 | | 2,022,338 |
| Total value, eliminating duplications | | 52,269,451 | | 61,723,268 |

[a] Value included under "Miscellaneous."
[b] Exclusive of puzzolan, value for which is included under "Miscellaneous."
[c] Figures obtained through cooperation with Bureau of the Census.
[d] Value not included in total value for State.
[e] Exclusive of marble, value for which is included under "Miscellaneous."
[f] Includes minerals indicated by "a," "b," and "e" above.

*Mineral production of Alaska in 1921 and 1922.*

| Product | 1921 | | 1922 | |
|---|---|---|---|---|
| | Quantity. | Value. | Quantity. | Value. |
| Coal short tons | 76,817 | $496,000 | 79,275 | $431,000 |
| Copper pounds | 57,011,597 | 7,354,496 | 77,967,819 | 10,525,655 |
| Gold troy ounces | 390,558 | 8,073,540 | 359,057 | 7,422,367 |
| Gypsum short tons | [a] | [a] | [a] | [a] |
| Lead do | 759 | 68,279 | 377 | 41,477 |
| Petroleum barrels | [b] | [b] | [b] | [b] |
| Platinum and allied metals troy ounces | 551 | 34,518 | 21 | 2,714 |
| Silver do | 761,085 | 761,085 | 729,945 | 729,945 |
| Stone short tons | [b] | [b] | [b] | [b] |
| Tin (metallic equivalent) do | 4 | 2,400 | 1 | 912 |
| Miscellaneous [c] | | 250,739 | | 352,540 |
| Total value, eliminating duplications | | 17,041,057 | | 19,506,610 |

[a] Calcined in Washington State. Value included under "Miscellaneous."
[b] Value included under "Miscellaneous."
[c] Includes minerals indicated by "a" and "b" above.

*Mineral production of Arizona in 1921 and 1922.*

| Product. | 1921 | | 1922 | |
|---|---|---|---|---|
| | Quantity. | Value. | Quantity. | Value. |
| Asbestos ..... short tons | 413 | $311,768 | [a] | [a] |
| Clay products ..... | | [b] 154,543 | | [b] $123,780 |
| Copper ..... pounds | 185,034,194 | 23,869,411 | 400,043,128 | 54,005,822 |
| Gems and precious stones ..... | | 8,805 | | [a] |
| Gold ..... troy ounces | 141,753 | 2,930,303 | 170,480 | 3,524,134 |
| Gypsum ..... short tons | 6,985 | 55,980 | 9,319 | 64,625 |
| Lead ..... do | 3,271 | 294,364 | 7,535 | 828,899 |
| Lime ..... do | 11,783 | 162,647 | [a] | [a] |
| Manganese ore ..... long tons | 328 | [a] | 203 | 2,572 |
| Pumice ..... short tons | | | [a] | [a] |
| Sand and gravel ..... do | 383,167 | 287,477 | 386,854 | 283,600 |
| Silver ..... troy ounces | 2,469,394 | 2,469,394 | 4,531,864 | 4,531,864 |
| Stone ..... short tons | [c] 256,510 | [c] 132,797 | 287,600 | 120,206 |
| Sulphuric acid [d] ..... do | [a b] | [a b] | [d] | [d] |
| Zinc ..... do | | | 105 | 12,006 |
| Miscellaneous [e] ..... | | 140,874 | | 240,212 |
| Total value, eliminating duplications ..... | | 30,818,363 | | 63,737,720 |

[a] Value included under "Miscellaneous."
[b] Figures obtained through cooperation with Bureau of the Census.
[c] Exclusive of limestone, value for which is included under "Miscellaneous."
[d] From copper smelting. No canvass for 1922.
[e] Includes minerals indicated by "[a]" and "[c]" above.

*Mineral production of Arkansas in 1921 and 1922.*

| Product. | 1921 | | 1922 | |
|---|---|---|---|---|
| | Quantity. | Value. | Quantity. | Value. |
| Antimony ore ..... short tons | | | 20 | [a] |
| Bauxite ..... long tons | 124,850 | $755,400 | 266,790 | $1,682,890 |
| Clay products ..... | | [b c] 731,668 | | [b c] 976,111 |
| Clay, raw ..... short tons | 193 | [d] 2,189 | 176 | [d] 1,848 |
| Coal ..... do | 1,227,777 | 5,360,000 | 1,110,046 | 4,592,000 |
| Fuller's earth ..... do | [e] | [e] | [e] | [e] |
| Gems and precious stones ..... | | [f] | | [f] |
| Gypsum ..... short tons | | | 600 | 1,800 |
| Lead ..... do | 21 | 1,890 | 42 | 4,620 |
| Lime ..... do | 8,958 | 93,499 | 11,951 | 115,008 |
| Manganese ore ..... long tons | 728 | 16,360 | 2,264 | 42,197 |
| Manganiferous ore ..... do | 278 | 3,683 | | |
| Marl, calcareous ..... short tons | 6,000 | 12,000 | [e] | [e] |
| Mineral waters ..... gallons sold | 313,322 | 31,984 | 248,460 | 28,866 |
| Natural gas ..... M cubic feet | 4,260,000 | 984,000 | 9,700,000 | 1,798,000 |
| Natural-gas gasoline ..... gallons | | | 4,288,955 | 629,491 |
| Oilstones ..... short tons | 122 | 80,626 | [e] | [e] |
| Petroleum ..... barrels | 10,473,000 | 12,746,000 | 12,712,000 | 20,416,000 |
| Sand and gravel ..... short tons | 1,464,007 | 782,812 | 839,773 | 522,121 |
| Stone ..... do | [g] 715,610 | [g] 821,169 | 300,970 | 417,729 |
| Zinc ..... do | 15 | 1,500 | 134 | 15,276 |
| Miscellaneous [h] ..... | | 92,821 | | 176,524 |
| Total value, eliminating duplications ..... | | 22,515,412 | | 31,418,633 |

[a] Ore shipped from mine, but no information regarding value.
[b] Exclusive of pottery, value for which is included under "Miscellaneous."
[c] Figures obtained through cooperation with Bureau of the Census.
[d] Value not included in total value for State.
[e] Value included under "Miscellaneous."
[f] No data available.
[g] Exclusive of marble, value for which is included under "Miscellaneous."
[h] Includes minerals indicated by "[b]", "[e]," and "[g]" above.

*Mineral production of California in 1921 and 1922.*

| Product. | 1921 | | 1922 | |
|---|---|---|---|---|
| | Quantity. | Value. | Quantity. | Value. |
| Asbestos short tons | 25 | $1,500 | (a) | (a) |
| Asphalt do | 226,987 | 3,732,812 | 333,161 | $4,541,999 |
| Barytes do | 942 | 5,084 | 3,338 | 17,707 |
| Borates do | 49,800 | 1,593,000 | (a) | (a) |
| Briquets, fuel do | (a b) | (a b) | (a b) | (a b) |
| Calcium chloride do | 1,000 | 12,000 | | |
| Cement barrels | 7,180,700 | 16,856,258 | 9,041,788 | 20,478,577 |
| Chromite long tons | 123 | 1,286 | 163 | 3,354 |
| Clay products | | c 11,172,491 | | c 14,689,830 |
| Clay, raw short tons | 181,039 | b 341,288 | 206,740 | b 396,201 |
| Coal do | (a) | (a) | (a) | (a) |
| Copper pounds | 11,743,404 | 1,514,899 | 22,539,485 | 3,042,830 |
| Diatomaceous earth short tons | d 50,000 | d 625,000 | (a) | (a) |
| Feldspar (crude) long tons | (a) | (a) | 2,378 | 17,510 |
| Gems and precious stones | | (a) | | (a) |
| Gold troy ounces | 759,721 | 15,704,822 | 709,678 | 14,670,346 |
| Graphite, crystalline pounds | (a) | (a) | (a) | (a) |
| Gypsum short tons | 40,526 | 151,570 | (a) | (a) |
| Iron ore long tons | 2,064 | 15,364 | 3,204 | 18,868 |
| Lead short tons | 562 | 50,592 | 3,156 | 347,189 |
| Lime do | 42,115 | 577,366 | 55,161 | 683,774 |
| Lithium minerals do | (a) | (a) | (a) | (a) |
| Magnesite do | 47,904 | 510,177 | 55,610 | 569,900 |
| Manganese ore long tons | | | (a) | (a) |
| Marl, calcareous short tons | (a) | (a) | 16,231 | 75,109 |
| Mineral paints, zinc and lead pigments do | (a b) | (a b) | (a b) | (a b) |
| Mineral waters gallons sold | 3,260,609 | 367,313 | 3,048,324 | 433,711 |
| Natural gas M cubic feet | 75,942,000 | 16,496,000 | 84,580,000 | 17,898,000 |
| Natural-gas gasoline gallons | 58,220,498 | 9,874,594 | 67,119,700 | 11,868,152 |
| Peat short tons | 12,672 | 117,580 | 10,938 | 115,943 |
| Pebbles for grinding do | (a) | (a) | (a) | (a) |
| Petroleum barrels | 112,600,000 | 203,138,000 | 138,468,000 | 173,381,000 |
| Platinum and allied metals troy ounces | 682 | 63,837 | 782 | 140,358 |
| Potash ($K_2O$) short tons | 2,106 | 193,951 | 10,102 | 393,953 |
| Pumice do | (a) | (a) | | |
| Pyrites long tons | 98,252 | 467,958 | (a) | (a) |
| Quicksilver flasks | 3,055 | 144,868 | 3,405 | 196,741 |
| Salt short tons | 193,618 | 1,043,912 | 257,790 | 1,211,197 |
| Sand and gravel do | 4,704,214 | 3,249,079 | 5,946,892 | 4,033,856 |
| Silica (quartz) do | (a) | (a) | 240 | 1,984 |
| Silver troy ounces | 3,629,223 | 3,629,223 | 3,100,065 | 3,100,065 |
| Sodium salts (carbonate, bicarbonate, and trona) from natural sources short tons | 17,000 | 601,250 | 33,537 | 690,021 |
| Stone do | 4,071,770 | 4,795,771 | 5,521,690 | 6,879,002 |
| Talc do | 8,233 | 128,188 | 12,638 | 187,011 |
| Zinc do | 529 | 52,887 | 1,506 | 171,738 |
| Miscellaneous e | | 493,877 | | 3,945,647 |
| Total value, eliminating duplications | | 297,025,679 | | 283,411,997 |

a Value included under "Miscellaneous."
b Value not included in total value for State.
c Figures obtained through cooperation with Bureau of the Census.
d Estimated.
e Includes minerals indicated by "a" above.

*Mineral production of Colorado in 1921 and 1922.*

| Product. | 1921 | | 1922 | |
|---|---|---|---|---|
| | Quantity. | Value. | Quantity. | Value. |
| Cement ..... barrels | (a) | (a) | (a) | (a) |
| Clay products | | [b] $2,741,668 | | [b] $3,431,197 |
| Clay, raw ..... short tons | 94,765 | [c] 119,091 | 148,450 | [c] 158,621 |
| Coal ..... do | [d] 9,122,760 | [d] 32,377,000 | 10,019,597 | 31,701,000 |
| Coke ..... do | 368,131 | [c] 3,086,728 | 484,039 | [c] 3,352,174 |
| Copper ..... pounds | 4,153,442 | 535,794 | 3,373,454 | 455,416 |
| Feldspar (crude) ..... long tons | (a) | (a) | 104 | 580 |
| Ferroalloys ..... do | (a c) | (a c) | (a c) | (a c) |
| Fluorspar ..... short tons | 3,143 | 39,907 | 2,309 | 20,169 |
| Gems and precious stones | | 3,848 | | (a) |
| Gold ..... troy ounces | 330,659 | 6,835,328 | 308,314 | 6,373,419 |
| Graphite, amorphous ..... short tons | (a) | (a) | | |
| Gypsum ..... do | (a) | (a) | (a) | (a) |
| Iron ore ..... long tons | 3,823 | (a) | 513 | (a) |
| Iron, pig ..... do | (a c) | (a c) | (a c) | (a c) |
| Lead ..... short tons | 9,830 | 884,721 | 11,739 | 1,291,246 |
| Lime ..... do | 5,783 | 56,956 | (a) | (a) |
| Manganese ore ..... long tons | 490 | (a) | | |
| Manganiferous ore: | | | | |
| For fluxing ..... do | 10,819 | 36,936 | 13,951 | (a) |
| For other purposes ..... do | 924 | | | |
| Mica, scrap ..... short tons | (a) | (a) | (a) | (a) |
| Mineral paints, zinc and lead pigments ..... do | (a c) | (a c) | (a c) | (a c) |
| Mineral waters ..... gallons sold | 234,560 | 70,925 | 146,626 | 55,283 |
| Natural gas ..... M cubic feet | 4,000 | 1,000 | 4,000 | 560 |
| Oil shale ..... short tons | 2 | 40 | | |
| Petroleum ..... barrels | 108,200 | 132,000 | 97,000 | 114,000 |
| Potash ($K_2O$) ..... short tons | (a) | (a) | (a) | (a) |
| Pyrites ..... long tons | 7,290 | 18,475 | | |
| Sand and gravel ..... short tons | 277,283 | 194,722 | 139,365 | 114,651 |
| Shale oil ..... gallons | [e] 5,000 | 1,000 | | |
| Silver ..... troy ounces | 5,631,657 | 5,631,657 | 5,855,911 | 5,855,911 |
| Stone ..... short tons | 333,840 | 559,605 | [f] 427,880 | [f] 555,694 |
| Sulphur ..... long tons | (a) | (a) | | |
| Uranium and vanadium ores ..... short tons | 8,487 | 870,560 | 591 | 73,875 |
| Zinc ..... do | 1,180 | 118,000 | 11,629 | 1,325,706 |
| Miscellaneous [g] | | 7,994,636 | | 9,498,292 |
| Total value, eliminating duplications | | 54,045,056 | | 54,806,277 |

[a] Value included under "Miscellaneous."
[b] Figures obtained through cooperation with Bureau of the Census.
[c] Value not included in total value for State.
[d] Exclusive of 14,869 tons produced at small mines, value for which is included under "Miscellaneous."
[e] Also 1,250 gallons used in manufacture of soap, stock dip, ointment, etc.
[f] Exclusive of marble, value for which is included under "Miscellaneous."
[g] Includes minerals indicated by "a," "d," and "f" above.

*Mineral production of Connecticut in 1921 and 1922.*

| Product. | 1921 | | 1922 | |
|---|---|---|---|---|
| | Quantity. | Value. | Quantity. | Value. |
| Clay products | | [a] $1,703,528 | | [a b] $2,379,023 |
| Clay, raw ..... short tons | 139 | [c] 480 | (c d) | (c d) |
| Diatomaceous earth ..... do | (d) | (d) | | |
| Feldspar (crude) ..... long tons | 9,565 | 65,864 | 7,499 | 47,887 |
| Gems and precious stones | | (d) | | |
| Iron, pig ..... long tons | (c d) | (c d) | (c d) | (c d) |
| Lime ..... short tons | (d) | (d) | 52,108 | 743,742 |
| Mica: | | | | |
| Scrap ..... do | | | (d) | (d) |
| Sheet ..... pounds | | | (d) | (d) |
| Mineral waters ..... gallons sold | 866,253 | 50,679 | 1,141,421 | 70,926 |
| Sand and gravel ..... short tons | 335,402 | 180,360 | 325,498 | 199,260 |
| Silica (quartz) ..... do | (d) | (d) | 2,129 | 11,177 |
| Stone ..... do | 1,252,860 | 1,529,746 | [e] 1,420,710 | [e] 1,585,461 |
| Miscellaneous [f] | | 712,149 | | 352,908 |
| Total value, eliminating duplications | | 4,219,457 | | 5,346,295 |

[a] Figures obtained through cooperation with Bureau of the Census.
[b] Exclusive of pottery, value for which is included under "Miscellaneous."
[c] Value not included in total value for State.
[d] Value included under "Miscellaneous."
[e] Exclusive of sandstone, value for which is included under "Miscellaneous."
[f] Includes minerals indicated by "b," "d," and "e" above.

*Mineral production of Delaware in 1921 and 1922.*

| Product. | 1921 | | 1922 | |
|---|---|---|---|---|
| | Quantity. | Value. | Quantity. | Value. |
| Clay products | | [a] $208,154 | | [a] $219,633 |
| Clay, raw short tons | 2,137 | [b] 17,314 | 4,203 | [b] 26,508 |
| Sand and gravel do | 43,958 | 25,347 | 32,492 | 30,561 |
| Stone do | [c] | [c] | [c] | [c] |
| Miscellaneous | | 146,284 | | 178,120 |
| Total value, eliminating duplications | | 379,785 | | 428,314 |

[a] Figures obtained through cooperation with Bureau of the Census.
[b] Value not included in total value for State.
[c] Value included under "Miscellaneous."

*Mineral production of the District of Columbia in 1921 and 1922.*

| Product. | 1921 | | 1922 | |
|---|---|---|---|---|
| | Quantity. | Value. | Quantity. | Value. |
| Clay products | | [a b] $138,188 | | [a b] $235,453 |
| Ferroalloys long tons | [c d] | [c d] | [c d] | [c d] |
| Sand and gravel short tons | [c] | [c] | [c] | [c] |
| Sand-lime brick thousands | [b e] | [b e] | [e] | [e] |
| Stone short tons | 12,360 | 12,087 | 11,110 | 18,658 |
| Miscellaneous [f] | | 272,655 | | 678,221 |
| Total value, eliminating duplications | | 411,745 | | 869,132 |

[a] Exclusive of pottery, value for which is included under "Miscellaneous."
[b] Figures obtained through cooperation with Bureau of the Census.
[c] Value included under "Miscellaneous."
[d] Value not included in total value for State.
[e] No canvass for 1922.
[f] Includes minerals indicated by "[a]" and "[c]" above.

*Mineral production of Florida in 1921 and 1922.*

| Product. | 1921 | | 1922 | |
|---|---|---|---|---|
| | Quantity. | Value. | Quantity. | Value. |
| Clay products | | [a] $178,809 | | [a b] $174,578 |
| Clay, raw short tons | 28,426 | [c] 388,751 | [c d] | [c d] |
| Fuller's earth do | 57,268 | 1,109,823 | 64,122 | 1,122,940 |
| Ilmenite do | | | 4,581 | 91,620 |
| Lime do | [d] | [d] | [d] | [d] |
| Mineral waters gallons sold | 321,472 | 28,365 | 1,004,984 | 57,305 |
| Monazite sand pounds | [e] | [e] | [e] | [e] |
| Peat short tons | [d] | [d] | 500 | 2,500 |
| Phosphate rock long tons | 1,780,028 | 10,431,642 | 2,058,593 | 8,347,522 |
| Sand and gravel short tons | 160,445 | 97,324 | 246,849 | 147,924 |
| Sand-lime brick thousands | [a d] | [a d] | [f] | [f] |
| Stone short tons | [g] 564,240 | [g] 471,895 | [g] 770,140 | [g] 706,644 |
| Zircon pounds | | | 20,100 | [h] 1,150 |
| Miscellaneous [i] | | 280,090 | | 770,501 |
| Total value, eliminating duplications | | 12,597,948 | | 10,907,718 |

[a] Figures obtained through cooperation with Bureau of the Census.
[b] Exclusive of pottery, value for which is included under "Miscellaneous."
[c] Value not included in total value for State.
[d] Value included under "Miscellaneous."
[e] No data available for publication.
[f] No canvass for 1922.
[g] Exclusive of flinty limestone, value for which is included under "Miscellaneous."
[h] Value estimated.
[i] Includes minerals indicated by "[b]," "[d]," and "[g]" above.

*Mineral production of Georgia in 1921 and 1922.*

| Product. | 1921 | | 1922 | |
|---|---|---|---|---|
| | Quantity. | Value. | Quantity. | Value. |
| Asbestos short tons | [a] | [a] | | |
| Barytes do | 24,614 | $191,442 | 57,045 | $468,517 |
| Bauxite long tons | 10,200 | 92,600 | 30,420 | 231,250 |
| Cement barrels | [a] | [a] | [a] | [a] |
| Clay products | | [b] 3,357,374 | | [b] 4,157,601 |
| Clay, raw short tons | 85,160 | [c] 430,215 | 233,828 | [c] 850,072 |
| Coal do | 33,815 | 171,000 | 60,636 | 246,000 |
| Coke do | 6,943 | [c] 80,828 | 8,832 | [c] 74,807 |
| Copper pounds | | | 6,000 | 810 |
| Fuller's earth short tons | [a] | [a] | 58,810 | 983,534 |
| Gold troy ounces | 49 | 1,022 | 156 | 3,224 |
| Iron ore: | | | | |
| Sold to furnaces long tons | 3,822 | 13,678 | 28,566 | 77,636 |
| Sold for paint do | [a] | [a] | | |
| Lead short tons | | | 4 | 440 |
| Lime do | [a] | [a] | [c] | [a] |
| Manganiferous ore long tons | 13,302 | [a] | 1,033 | [a] |
| Mica: | | | | |
| Scrap short tons | 75 | 1,700 | 224 | 7,247 |
| Sheet pounds | 12,730 | 2,640 | 8,818 | 4,083 |
| Mineral waters gallons sold | 306,637 | 22,757 | 424,290 | 36,856 |
| Peat short tons | [a] | [a] | | |
| Pyrites long tons | [a] | [a] | | |
| Sand and gravel short tons | 329,048 | 177,745 | 461,359 | 191,420 |
| Sand-lime brick thousands | [a b] | [a b] | [d] | [d] |
| Silver troy ounces | 4 | 4 | 364 | 364 |
| Slate | | [a] | | [a] |
| Stone short tons | 362,630 | 2,924,035 | 444,590 | 3,349,293 |
| Talc do | [a] | [a] | 1,506 | 40,042 |
| Miscellaneous [e] | | 1,724,006 | | 1,321,701 |
| Total value, eliminating duplications | | 8,650,003 | | 11,120,018 |

[a] Value included under "Miscellaneous."
[b] Figures obtained through cooperation with Bureau of the Census.
[c] Value not included in total value for State.
[d] No canvass for 1922.
[e] Includes minerals indicated by "[a]" above.

*Mineral production of Idaho in 1921 and 1922.*

| Product. | 1921 | | 1922 | |
|---|---|---|---|---|
| | Quantity. | Value. | Quantity. | Value. |
| Asbestos short tons | [a] | [a] | | |
| Barytes do | | | [a] | [a] |
| Clay products | | [b] $78,653 | | [b] $128,259 |
| Clay, raw short tons | 196 | [c] 2,369 | 394 | [c] 2,410 |
| Coal do | [a] | [a] | [a] | [a] |
| Copper pounds | 1,688,195 | 217,777 | 3,282,842 | 443,184 |
| Gems and precious stones | | | | [a] |
| Gold troy ounces | 26,400 | 545,731 | 24,255 | 501,405 |
| Iron ore long tons | 799 | [a] | 25 | [a] |
| Lead short tons | 99,235 | 8,931,110 | 97,917 | 10,770,881 |
| Lime do | [a] | [a] | [a] | [a] |
| Phosphate rock long tons | [a] | [a] | 4,481 | 19,692 |
| Platinum and allied metals troy ounces | | | 7 | 857 |
| Quicksilver flasks | 1 | 47 | | |
| Salt short tons | | | 21 | 240 |
| Sand and gravel do | 266,853 | 107,000 | 79,651 | 38,775 |
| Silver troy ounces | 6,080,528 | 6,080,528 | 6,081,865 | 6,081,865 |
| Stone short tons | [d] 273,490 | [d] 478,730 | 166,650 | 235,241 |
| Zinc do | 17 | 1,673 | 2,055 | 234,220 |
| Miscellaneous [e] | | 61,024 | | 41,009 |
| Total value, eliminating duplications | | 16,502,273 | | 18,495,628 |

[a] Value included under "Miscellaneous."
[b] Figures obtained through cooperation with Bureau of the Census.
[c] Value not included in total value for State.
[d] Exclusive of sandstone, value for which is included under "Miscellaneous."
[e] Includes minerals indicated by "[a]" and "[a]" above.

*Mineral production of Illinois in 1921 and 1922.*

| Product. | 1921 | | 1922 | |
|---|---|---|---|---|
| | Quantity. | Value. | Quantity. | Value. |
| Asphalt short tons | 129,183 | $1,372,891 | 167,030 | $1,794,554 |
| Barytes do | [a] | [a] | [a] | [a] |
| Cement barrels | [b] 5,237,510 | [b] 9,092,982 | [b] 6,554,945 | [b] 10,584,171 |
| Clay products | | [c] 19,041,182 | | [c] 26,784,263 |
| Clay, raw short tons | 89,060 | [d] 177,004 | 130,323 | [d] 242,487 |
| Coal do | 69,602,763 | 190,986,000 | 58,467,736 | 168,925,000 |
| Coke do | 1,322,178 | [d] 11,383,808 | 1,982,906 | [d] 18,164,549 |
| Ferroalloys long tons | [a d] | [a d] | [a d] | [a d] |
| Fluorspar short tons | 12,477 | 315,767 | 83,855 | 1,493,188 |
| Fuller's earth do | | | [a] | [a] |
| Iron, pig long tons | 1,490,638 | [d] 36,513,263 | 2,729,172 | [d] 58,954,675 |
| Lead short tons | 672 | 60,480 | 1,325 | 145,750 |
| Lime do | 58,222 | 610,197 | 85,425 | 860,945 |
| Mineral paints, zinc and lead pigments do | [a d] | [a d] | [a d] | [a d] |
| Mineral waters gallons sold | 351,277 | 21,871 | 335,974 | 18,679 |
| Natural gas M cubic feet | 2,646,000 | 356,000 | 3,383,000 | 424,040 |
| Natural-gas gasoline gallons | 7,536,073 | 1,101,227 | 7,760,011 | 1,181,797 |
| Peat short tons | [a] | [a] | [a] | [a] |
| Petroleum barrels | 10,043,000 | 20,632,000 | 9,383,000 | 19,291,000 |
| Sand and gravel short tons | 6,459,692 | 4,016,806 | 8,840,293 | 5,411,821 |
| Sand and sandstone (finely ground) do | 33,291 | 230,001 | 66,792 | 378,729 |
| Silver troy ounces | 1,345 | 1,345 | 6,025 | 6,025 |
| Stone short tons | 4,330,620 | 4,352,960 | 6,781,310 | 6,473,566 |
| Sulphuric acid (60° Baumé) [e] do | [c] 134,503 | [c] 1,351,654 | [e] | [e] |
| Tripoli do | 7,765 | 125,352 | 18,747 | 194,371 |
| Zinc do | 2,426 | 242,600 | 3,124 | 356,136 |
| Miscellaneous [f] | | 1,963,376 | | 1,577,130 |
| Total value, eliminating duplications | | 254,019,136 | | 244,617,561 |

[a] Value included under "Miscellaneous."
[b] Exclusive of natural cement, value for which is included under "Miscellaneous."
[c] Figures obtained through cooperation with Bureau of the Census.
[d] Value not included in total value for State.
[e] From zinc smelting. No canvass for 1922.
[f] Includes minerals indicated by "[a]" and "[b]" above.

*Mineral production of Indiana in 1921 and 1922.*

| Product. | 1921 | | 1922 | |
|---|---|---|---|---|
| | Quantity. | Value. | Quantity. | Value. |
| Asphalt short tons | | | [a] | [a] |
| Cement barrels | [a] | [a] | [c] | [a] |
| Clay products | | [b] $11,199,024 | | [b] $13,942,139 |
| Clay, raw short tons | 43,092 | [c] 68,937 | 45,446 | [c] 74,288 |
| Coal do | 20,319,509 | 52,269,000 | 19,132,889 | 54,524,000 |
| Coke do | 3,091,263 | [c] 19,007,519 | 3,995,505 | [c] 28,978,431 |
| Iron, pig long tons | 1,655,275 | [c] 36,945,411 | 2,191,356 | [c] 43,064,817 |
| Lime short tons | 90,542 | 826,311 | 113,246 | 938,645 |
| Mineral paints, zinc and lead pigments do | | | [a c] | [a c] |
| Mineral waters gallons sold | 541,190 | 158,790 | 514,211 | 156,358 |
| Natural gas M cubic feet | 1,066,000 | 547,000 | 947,000 | 476,172 |
| Oilstones and scythestones short tons | 199 | 28,426 | 445 | 43,637 |
| Petroleum barrels | 1,158,000 | 2,414,000 | 1,087,000 | 2,225,000 |
| Sand and gravel short tons | 5,277,504 | 2,781,299 | 5,824,330 | 2,977,008 |
| Sand-lime brick thousands | [a b] | [a b] | [d] | [d] |
| Stone short tons | 2,489,890 | 8,985,036 | 2,775,740 | 13,203,146 |
| Miscellaneous [e] | | 18,491,790 | | 19,975,090 |
| Total value, eliminating duplications | | 97,700,676 | | 108,394,095 |

[a] Value included under "Miscellaneous."
[b] Figures obtained through cooperation with Bureau of the Census.
[c] Value not included in total value for State.
[d] No canvass for 1922.
[e] Includes minerals indicated by "[a]" above.

*Mineral production of Iowa in 1921 and 1922.*

| Product. | 1921 | | 1922 | |
|---|---|---|---|---|
| | Quantity. | Value. | Quantity. | Value. |
| Cement ..... barrels | 4,151,439 | $7,439,983 | 4,475,074 | $7,709,313 |
| Clay products | | [a] [b] 5,711,583 | | [a] [b] 5,739,449 |
| Clay, raw ..... short tons | 7,457 | [a] 7,617 | 22,887 | [c] 23,068 |
| Coal ..... do | 4,531,392 | 17,256,800 | 4,335,161 | 16,119,000 |
| Ferroalloys ..... long tons | [c] [d] | [c] [d] | [c] [d] | [c] [d] |
| Gypsum ..... short tons | 350,247 | 2,922,700 | 536,905 | 4,146,182 |
| Lime ..... do | [d] | [d] | [d] | [d] |
| Mineral waters ..... gallons sold | 21,100 | 2,105 | 25,561 | 3,788 |
| Natural gas ..... M cubic feet | 700 | 300 | 500 | 250 |
| Sand and gravel ..... short tons | 2,641,982 | 1,726,958 | 2,690,798 | 1,752,233 |
| Stone ..... do | 417,890 | 516,730 | 620,810 | 657,161 |
| Miscellaneous [e] | | 265,923 | | 607,499 |
| Total value, eliminating duplications | | 35,639,505 | | 36,205,251 |

[a] Exclusive of pottery, value for which is included under "Miscellaneous."
[b] Figures obtained through cooperation with Bureau of the Census.
[c] Value not included in total value for State.
[d] Value included under "Miscellaneous."
[e] Includes minerals indicated by "[a]" and "[d]" above.

*Mineral production of Kansas in 1921 and 1922.*

| Product. | 1921 | | 1922 | |
|---|---|---|---|---|
| | Quantity. | Value. | Quantity. | Value. |
| Asphalt ..... short tons | [a] | [a] | [a] | [a] |
| Cement ..... barrels | [b] 3,643,582 | [b] $7,253,944 | [b] 4,556,517 | [b] $8,138,268 |
| Clay products | | [c] 3,739,594 | | [c] 3,715,819 |
| Coal ..... short tons | 3,466,641 | 13,333,300 | 2,955,170 | 10,816,000 |
| Gypsum ..... do | 92,526 | 665,164 | 105,481 | 690,740 |
| Lead ..... do | 18,679 | 1,681,110 | 23,271 | 2,559,810 |
| Mineral paints, zinc and lead pigments ..... do | [a] [d] | [a] [d] | [a] [d] | [a] [d] |
| Mineral waters ..... gallons sold | 421,294 | 55,982 | 383,600 | 64,554 |
| Natural gas ..... M cubic feet | 15,717,000 | 7,382,000 | 20,289,000 | 9,123,000 |
| Natural-gas gasoline ..... gallons | 3,587,329 | 565,408 | 2,855,573 | 435,056 |
| Petroleum ..... barrels | 36,456,000 | 68,694,000 | 31,766,000 | 56,131,000 |
| Pumice ..... short tons | 34,172 | 125,642 | [a] | [a] |
| Salt ..... do | 665,968 | 3,268,661 | 759,459 | 3,849,427 |
| Sand and gravel ..... do | 1,082,914 | 647,723 | 1,398,996 | 790,763 |
| Stone ..... do | 378,680 | 675,145 | 657,660 | 895,476 |
| Sulphuric acid [e] ..... do | [a] [c] | [a] [c] | [e] | [e] |
| Zinc ..... do | 36,994 | 3,699,400 | 56,225 | 6,409,650 |
| Miscellaneous [f] | | 1,913,259 | | 1,444,763 |
| Total value, eliminating duplications | | 113,098,346 | | 103,884,561 |

[a] Value included under "Miscellaneous."
[b] Exclusive of natural cement, value for which is included under "Miscellaneous."
[c] Figures obtained through cooperation with Bureau of the Census.
[d] Value not included in total value for State.
[e] From zinc smelting. No canvass for 1922.
[f] Includes minerals indicated by "[a]" and "[b]" above.

*Mineral production of Kentucky in 1921 and 1922.*

| Product. | 1921 | | 1922 | |
|---|---|---|---|---|
| | Quantity. | Value. | Quantity. | Value. |
| Asphalt short tons | [a] | [a] | [a] | [a] |
| Cement barrels | [a] | [a] | [a] | [a] |
| Clay products | | [b] $4,322,781 | | [b c] $4,986,502 |
| Clay, raw short tons | 35,587 | [d] 204,400 | 67,591 | [d] 270,858 |
| Coal do | 31,588,270 | 85,092,600 | 42,134,175 | 127,037,000 |
| Coke do | 284,825 | [d] 1,863,707 | 487,167 | [d] 3,614,140 |
| Fluorspar do | 15,266 | 294,513 | 52,484 | 970,059 |
| Iron, pig long tons | 28,375 | [d] 816,372 | 140,217 | [d] 2,951,627 |
| Lead short tons | 69 | 6,210 | 92 | 10,120 |
| Lime do | 1,524 | 11,551 | 1,560 | 11,062 |
| Mineral waters gallons sold | 255,475 | 37,174 | 191,275 | 30,430 |
| Natural gas M cubic feet | 4,820,000 | 1,597,000 | 5,872,000 | 1,879,000 |
| Natural-gas gasoline gallons | 4,241,038 | 834,983 | 5,204,883 | 925,810 |
| Oilstones short tons | [a] | [a] | [a] | [a] |
| Petroleum barrels | 9,012,600 | 16,736,000 | 8,973,200 | 17,758,000 |
| Phosphate rock long tons | [a] | [a] | [a] | [a] |
| Sand and gravel short tons | 1,356,512 | 963,584 | 1,517,759 | 937,649 |
| Stone do | 1,573,750 | 1,877,487 | 1,537,690 | 1,853,851 |
| Zinc do | 220 | 22,000 | 142 | 16,188 |
| Miscellaneous [e] | | 2,608,779 | | 2,285,825 |
| Total value, eliminating duplications | | 114,404,662 | | 158,701,496 |

[a] Value included under "Miscellaneous."
[b] Figures obtained through cooperation with Bureau of the Census.
[c] Exclusive of pottery, value for which is included under "Miscellaneous."
[d] Value not included in total value for State.
[e] Includes minerals indicated by "[a]" and "[c]" above.

*Mineral production of Louisiana in 1921 and 1922.*

| Product. | 1921 | | 1922 | |
|---|---|---|---|---|
| | Quantity. | Value. | Quantity. | Value. |
| Clay products | | [a b] $587,868 | | [a b] $578,615 |
| Mineral waters gallons sold | [c] | [c] | [c] | [c] |
| Natural gas M cubic feet | 58,004,000 | 5,460,000 | 70,267,000 | 5,849,000 |
| Natural-gas gasoline gallons | 15,340,374 | 1,812,268 | 29,406,282 | 4,112,655 |
| Petroleum barrels | 27,103,000 | 42,469,000 | 35,376,000 | 53,169,000 |
| Salt short tons | [c] | [c] | 336,852 | 1,657,708 |
| Sand and gravel do | 1,821,695 | 1,491,406 | 1,711,292 | 1,106,807 |
| Sand-lime brick thousands | [b c] | [b c] | [d] | [d] |
| Stone short tons | [c] | [c] | [c] | [c] |
| Sulphur long tons | [c] | [c] | [c] | [c] |
| Miscellaneous [e] | | 9,241,432 | | 9,045,543 |
| Total value, eliminating duplications | | 61,061,974 | | 75,519,328 |

[a] Exclusive of pottery, value for which is included under "Miscellaneous."
[b] Figures obtained through cooperation with Bureau of the Census.
[c] Value included under "Miscellaneous."
[d] No canvass for 1922.
[e] Includes minerals indicated by "[a]" and "[c]" above.

*Mineral production of Maine in 1921 and 1922.*

| Product. | 1921 | | 1922 | |
|---|---|---|---|---|
| | Quantity. | Value. | Quantity. | Value. |
| Clay products | | [a] $631,480 | | [a] $768,725 |
| Feldspar (crude) long tons | 18,866 | 134,168 | 21,692 | 221,478 |
| Ferroalloys do | [b c] | [b c] | | |
| Gems and precious stones | | [b] | | [b] |
| Lime short tons | 90,585 | 1,392,850 | 127,840 | 1,757,480 |
| Mineral waters gallons sold | 744,775 | 309,757 | 928,149 | 368,939 |
| Peat short tons | | | [b] | [b] |
| Sand and gravel do | 40,884 | 36,359 | 100,179 | 102,901 |
| Slate | | 409,303 | | 464,713 |
| Stone short tons | 201,490 | 1,477,522 | 191,760 | 1,903,084 |
| Miscellaneous [d] | | 7,968 | | 820 |
| Total value, eliminating duplications | | 4,392,039 | | 5,588,140 |

[a] Figures obtained through cooperation with Bureau of the Census.
[b] Value included under "Miscellaneous."
[c] Value not included in total value for State.
[d] Includes minerals indicated by "[b]" above.

*Mineral production of Maryland in 1921 and 1922.*

| Product. | 1921 | | 1922 | |
|---|---|---|---|---|
| | Quantity. | Value. | Quantity. | Value. |
| Asbestos short tons | 3 | $12,000 | (a) | (a) |
| Cement barrels | (a) | (a) | (a) | (a) |
| Chromite long tons | | | 113 | $3,302 |
| Clay products | | [b] 2,541,888 | | [b] 3,596,004 |
| Clay, raw short tons | 26,108 | [c] 54,471 | 72,749 | [c] 147,969 |
| Coal do | 1,827,740 | 6,602,000 | 1,222,707 | 4,122,000 |
| Coke do | 292,439 | (ac) | 589,893 | (ac) |
| Diatomaceous earth do | (a) | (a) | (a) | (a) |
| Feldspar (crude) long tons | 5,155 | 33,798 | 2,899 | 18,099 |
| Ferroalloys do | (ac) | (ac) | (ac) | (ac) |
| Iron ore do | 1,580 | (a) | | |
| Iron, pig do | (ac) | (ac) | 423,533 | (ac) |
| Lime short tons | 64,835 | 558,785 | 71,261 | 554,194 |
| Marl, calcareous do | 170 | 680 | 100 | 450 |
| Mineral waters gallons sold | 888,948 | 87,138 | 749,624 | 73,890 |
| Natural gas M cubic feet | 200 | 100 | | |
| Potash ($K_2O$) short tons | (a) | (a) | | |
| Sand and gravel do | 1,543,453 | 1,592,735 | 1,586,915 | 1,606,376 |
| Silica (quartz) do | (a) | (a) | (a) | (a) |
| Slate | | (a) | | (a) |
| Stone short tons | 896,520 | 1,457,937 | 997,260 | 1,435,923 |
| Talc do | (a) | (a) | 1,667 | 14,667 |
| Miscellaneous [d] | | 6,783,797 | | 16,907,766 |
| Total value, eliminating duplications | | 16,083,965 | | 14,905,227 |

[a] Value included under "Miscellaneous."
[b] Figures obtained through cooperation with Bureau of the Census.
[c] Value not included in total value for State.
[d] Includes minerals indicated by "a" above.

*Mineral production of Massachusetts in 1921 and 1922.*

| Product. | 1921 | | 1922 | |
|---|---|---|---|---|
| | Quantity. | Value. | Quantity. | Value. |
| Clay products | | [a] $2,030,389 | | [a] $2,502,614 |
| Clay, raw short tons | 26 | [b] 90 | 1,012 | [b] 3,941 |
| Coke do | 294,059 | (bc) | 407,081 | (bc) |
| Fuller's earth do | (c) | (c) | (c) | (c) |
| Gems and precious stones | | (c) | | |
| Iron ore long tons | 1,262 | (c) | 4,368 | (c) |
| Iron, pig do | (bc) | (bc) | 510 | (bc) |
| Lime short tons | 124,183 | 1,890,512 | 164,980 | 2,510,368 |
| Mineral waters gallons sold | 1,088,921 | 72,792 | 1,417,111 | 81,674 |
| Peat short tons | (c) | (c) | (c) | (c) |
| Sand and gravel do | 1,121,954 | 1,201,441 | 1,600,581 | 1,499,170 |
| Sand and sandstone (finely ground) do | | | (c) | (c) |
| Sand-lime brick thousands | (ae) | (ac) | (d) | (d) |
| Stone short tons | 1,446,130 | 4,582,941 | 1,607,970 | 4,375,387 |
| Talc do | (c) | (c) | | |
| Miscellaneous [e] | | 3,338,535 | | 5,988,442 |
| Total value, eliminating duplications | | 9,835,107 | | 11,004,523 |

[a] Figures obtained through cooperation with Bureau of the Census.
[b] Value not included in total value for State.
[c] Value included under "Miscellaneous."
[d] No canvass for 1922.
[e] Includes minerals indicated by "c" above.

*Mineral production of Michigan in 1921 and 1922.*

| Product. | 1921 | | 1922 | |
|---|---|---|---|---|
| | Quantity. | Value. | Quantity. | Value. |
| Bromine.....pounds.. | [a] | [a] | [a] | [a] |
| Calcium chloride.....short tons.. | 18,683 | $431,402 | 24,998 | $488,404 |
| Cement.....barrels.. | 5,680,156 | 10,300,289 | 6,349,751 | 11,145,573 |
| Clay products..... | ..... | [b] 4,697,842 | ..... | [b] 4,296,213 |
| Clay, raw.....short tons.. | 692 | [c] 2,355 | 1,653 | [c] 4,852 |
| Coal.....do.... | 1,141,715 | 5,555,000 | 929,390 | 4,693,000 |
| Coke.....do.... | 777,125 | [c] 7,050,191 | 1,142,059 | [c] 9,229,083 |
| Copper.....pounds.. | 86,370,028 | 11,141,734 | 121,712,365 | 16,431,169 |
| Gems and precious stones..... | ..... | [a] | ..... | [a] |
| Grindstones.....short tons.. | [a] | [a] | [a] | [a] |
| Gypsum.....do.... | 408,224 | 3,312,096 | 471,355 | 2,843,117 |
| Iron ore: | | | | |
| Sold to furnaces.....long tons.. | 5,011,804 | 18,481,225 | 12,457,856 | 43,449,513 |
| Sold for paint.....do.... | 1,825 | [a] | 3,971 | [a] |
| Iron, pig.....do.... | 200,944 | [c] 5,955,205 | 595,647 | [c] 14,791,041 |
| Lime.....short tons.. | 48,164 | 445,386 | 53,635 | 484,945 |
| Magnesium.....pounds.. | [d] | [d] | [d] | [d] |
| Manganiferous ore.....long tons.. | 51 | [c] | 9,644 | [a] |
| Mineral waters.....gallons sold.. | 1,344,900 | 154,401 | 1,229,802 | 150,237 |
| Natural gas.....M cubic feet.. | 400 | 300 | 700 | 350 |
| Peat.....short tons.. | [a] | [a] | 1,792 | 26,248 |
| Salt.....do.... | 1,427,465 | 7,439,445 | 2,005,088 | 8,693,604 |
| Sand and gravel.....do.... | 5,515,253 | 2,916,917 | 5,962,916 | 3,222,043 |
| Sand-lime brick.....thousands.. | [b] 33,658 | [b] 403,929 | [e] | [e] |
| Silica (quartz).....short tons.. | [a] | [a] | ..... | ..... |
| Silver.....troy ounces.. | 310,727 | 310,727 | 376,990 | 376,990 |
| Stone.....short tons.. | 5,506,710 | 3,657,862 | [f] 7,741,110 | [f] 4,910,786 |
| Miscellaneous [g] ..... | ..... | 204,264 | ..... | 218,789 |
| Total value, eliminating duplications.... | ..... | 69,452,819 | ..... | 101,430,981 |

[a] Value included under "Miscellaneous."
[b] Figures obtained through cooperation with Bureau of the Census.
[c] Value not included in total value for State.
[d] Information withheld by producer.
[e] No canvass for 1922.
[f] Exclusive of sandstone, value for which is included under "Miscellaneous."
[g] Includes minerals indicated by "a" and "f" above.

*Mineral production of Minnesota in 1921 and 1922.*

| Product. | 1921 | | 1922 | |
|---|---|---|---|---|
| | Quantity. | Value. | Quantity. | Value. |
| Cement.....barrels.. | [a] | [a] | [a] | [a] |
| Clay products..... | ..... | [b e] $2,482,286 | ..... | [b c] $2,201,502 |
| Clay, raw.....short tons.. | 29,222 | [c d] 43,065 | 19,078 | [d] 25,287 |
| Coke.....do.... | 435,866 | [d] 4,337,016 | 462,044 | [d] 4,641,871 |
| Flint lining for tube mills.....do.... | [a] | [a] | [a] | [a] |
| Gems and precious stones..... | ..... | [a] | ..... | [a] |
| Iron ore: | | | | |
| Sold to furnaces.....long tons.. | 17,648,603 | 62,780,754 | 30,209,372 | 98,903,398 |
| Sold for paint.....do.... | 169 | [a] | ..... | ..... |
| Iron, pig.....do.... | [a d] | [a d] | 177,297 | [a d] |
| Lime.....short tons.. | 22,109 | 232,037 | 27,670 | 307,270 |
| Manganiferous ore.....long tons.. | 56,530 | [a] | 553,653 | 1,562,589 |
| Mineral waters.....gallons sold.. | 2,266,578 | 132,127 | 2,962,160 | 156,066 |
| Peat.....short tons.. | [a] | [a] | ..... | ..... |
| Pebbles for grinding.....do.... | [a] | [a] | [a] | [a] |
| Sand and gravel.....do.... | 1,663,820 | 1,135,042 | 1,900,532 | 1,332,567 |
| Sand-lime brick.....thousands.. | [a c] | [a c] | [e] | [e] |
| Stone.....short tons.. | [f] 362,850 | [f] 2,034,368 | 656,970 | 3,163,716 |
| Miscellaneous [g] ..... | ..... | 7,178,554 | ..... | 8,024,399 |
| Total value, eliminating duplications.... | ..... | 72,609,973 | ..... | 111,617,448 |

[a] Value included under "Miscellaneous."
[b] Exclusive of pottery, value for which is included under "Miscellaneous."
[c] Figures obtained through cooperation with Bureau of the Census.
[d] Value not included in total value for State.
[e] No canvass for 1922.
[f] Exclusive of basalt, value for which is included under "Miscellaneous."
[g] Includes minerals indicated by "a," "b," and "f" above.

*Mineral production of Mississippi in 1921 and 1922.*

| Product. | 1921 | | 1922 | |
|---|---|---|---|---|
| | Quantity. | Value. | Quantity. | Value. |
| Clay products | | [a] $737,967 | | [a] $691,779 |
| Clay, raw, short tons | 1,000 | [b] 2,000 | 1,080 | [b] 2,160 |
| Mineral waters, gallons sold | 140,600 | 31,945 | 100,548 | 25,966 |
| Sand and gravel, short tons | 2,455,405 | 1,183,197 | 1,787,497 | 881,483 |
| Stone, do | [c] | [c] | [c] | [c] |
| Miscellaneous | | 1,244 | | 1,165 |
| Total value, eliminating duplications | | 1,954,353 | | 1,600,393 |

[a] Figures obtained through cooperation with Bureau of the Census.
[b] Value not included in total value for State.
[c] Value included under "Miscellaneous."

*Mineral production of Missouri in 1921 and 1922.*

| Product. | 1921 | | 1922 | |
|---|---|---|---|---|
| | Quantity. | Value. | Quantity. | Value. |
| Barytes, short tons | 25,200 | $217,913 | 66,421 | $421,568 |
| Briquets, fuel, do | [a b] | [a b] | [a b] | [a b] |
| Cement, barrels | 4,375,712 | 8,034,540 | 6,239,144 | 10,457,557 |
| Chats, short tons | 1,730,473 | [c] 260,000 | 1,141,759 | [c] 175,000 |
| Clay products | | [d] 10,668,691 | | [d] 11,746,008 |
| Clay, raw, short tons | 256,783 | [b] 938,135 | 412,128 | [b] 1,238,622 |
| Coal, do | 3,551,621 | 13,915,500 | 2,924,750 | 11,153,000 |
| Coke, do | [a b] | [a b] | [a b] | [a b] |
| Copper, pounds | 137,591 | 17,749 | 797,400 | 107,649 |
| Iron ore: | | | | |
| Sold to furnaces, long tons | 36,431 | [a] | 58,320 | 244,928 |
| Sold for paint, do | | | 38 | [e] |
| Iron, pig, do | 17,028 | [b] 479,957 | 7,700 | [a b] |
| Lead, short tons | 180,085 | 16,207,650 | 178,412 | 19,625,320 |
| Lime, do | 159,194 | 1,656,560 | 203,984 | 1,953,524 |
| Mineral paints, zinc and lead pigments, do | [a b] | [a b] | [a b] | [a b] |
| Mineral waters, gallons sold | 176,541 | 45,670 | 141,369 | 40,149 |
| Natural gas, M cubic feet | 4,000 | 3,000 | 2,600 | 2,028 |
| Petroleum, barrels | [a] | [a] | [a] | [c] |
| Sand and gravel, short tons | 1,539,073 | 1,018,325 | 1,970,345 | 1,063,370 |
| Silver, troy ounces | 69,902 | 69,902 | 212,656 | 212,656 |
| Stone, short tons | 1,385,250 | 2,978,575 | 1,611,020 | 3,322,672 |
| Tripoli, do | [a] | [a] | [a] | [a] |
| Zinc, do | 10,845 | 1,084,500 | 16,171 | 1,843,494 |
| Miscellaneous [e] | | 3,254,790 | | 3,427,464 |
| Total value, eliminating duplications | | 56,375,543 | | 62,402,642 |

[a] Value included under "Miscellaneous."
[b] Value not included in total value for State.
[c] Value estimated.
[d] Figures obtained through cooperation with Bureau of the Census.
[e] Includes minerals indicated by "a" above.

*Mineral production of Montana in 1921 and 1922.*

| Product. | 1921 | | 1922 | |
|---|---|---|---|---|
| | Quantity. | Value. | Quantity. | Value. |
| Cement—barrels | [a] | [a] | [a] | [a] |
| Clay products | | [b] $175,386 | | [b] $290,781 |
| Clay, raw—short tons | 523 | [c] 2,811 | 7,363 | [c] 11,416 |
| Coal—do | 2,733,958 | 8,921,600 | 2,572,221 | 8,208,500 |
| Copper—pounds | 48,098,730 | 6,204,736 | 165,754,442 | 22,376,850 |
| Ferroalloys—long tons | [a c] | [a c] | [a c] | [a c] |
| Gems and precious stones | | 489,021 | | [a] |
| Gold—troy ounces | 71,632 | 1,480,763 | 80,146 | 1,656,757 |
| Gypsum—short tons | [a] | [a] | [a] | [a] |
| Iron ore—long tons | 26,174 | 91,729 | 21,726 | 59,566 |
| Lead—short tons | 10,183 | 916,511 | 14,884 | 1,637,211 |
| Lime—do | [a] | [a] | [a] | [a] |
| Manganese ore: | | | | |
| For fluxing—long tons | | | 2,278 | 17,341 |
| For other purposes—do | 11,129 | 444,981 | 9,751 | 371,245 |
| Manganiferous ore (for fluxing)—do | | | 6,656 | 28,000 |
| Mineral waters—gallons sold | [a] | [a] | [a] | [a] |
| Natural gas—M cubic feet | 336,000 | 89,300 | 486,000 | 88,300 |
| Petroleum—barrels | 1,509,000 | 2,373,000 | 2,449,000 | 4,048,000 |
| Phosphate rock—long tons | [a] | [a] | | |
| Sand and gravel—short tons | 68,377 | 79,812 | 79,604 | 56,119 |
| Silver—troy ounces | 6,558,713 | 6,558,713 | 12,468,151 | 12,468,151 |
| Stone—short tons | [d] 95,520 | [d] 108,022 | [e] 184,010 | [e] 211,293 |
| Zinc—do | 11,638 | 1,163,798 | 59,535 | 6,786,980 |
| Miscellaneous [f] | | 1,064,375 | | 1,100,342 |
| Total value, eliminating duplications | | 30,161,734 | | 59,400,591 |

[a] Value included under "Miscellaneous."
[b] Figures obtained through cooperation with Bureau of the Census.
[c] Value not included in total value for State.
[d] Exclusive of basalt, value for which is included under "Miscellaneous."
[e] Exclusive of sandstone, value for which is included under "Miscellaneous."
[f] Includes minerals indicated by "[a]," "[d]," and "[e]" above.

*Mineral production of Nebraska in 1921 and 1922.*

| Product. | 1921 | | 1922 | |
|---|---|---|---|---|
| | Quantity. | Value. | Quantity. | Value. |
| Cement—barrels | [a] | [a] | [a] | [a] |
| Clay products | | [b c] $779,087 | | [b c] $857,185 |
| Clay, raw—short tons | 55 | [d] 350 | 248 | [d] 890 |
| Mineral paints, zinc and lead pigments—short tons | [a d] | [a d] | | |
| Potash ($K_2O$)—do | 337 | 33,700 | [a] | [a] |
| Pumice—do | [a] | [a] | [a] | [a] |
| Sand and gravel—do | 1,018,992 | 529,218 | 1,513,257 | 805,215 |
| Stone—do | 148,880 | 202,266 | 182,960 | 231,195 |
| Miscellaneous [e] | | 822,700 | | 1,102,992 |
| Total value, eliminating duplications | | 2,366,287 | | 2,996,587 |

[a] Value included under "Miscellaneous."
[b] Exclusive of pottery, value for which is included under "Miscellaneous."
[c] Figures obtained through cooperation with Bureau of the Census.
[d] Value not included in total value for State.
[e] Includes minerals indicated by "[a]" and "[b]" above.

*Mineral production of Nevada in 1921 and 1922.*

| Product. | 1921 | | 1922 | |
|---|---|---|---|---|
| | Quantity. | Value. | Quantity. | Value. |
| Borates.....short tons | 200 | $7,000 | [a] | [a] |
| Clay products | | [a b] | | [a b] |
| Clay, raw.....short tons | | | [a c] | [a c] |
| Cobalt.....pounds | | | 4,018 | $1,419 |
| Copper.....do | 10,961,491 | 1,414,032 | 23,133,091 | 3,122,967 |
| Diatomaceous earth.....short tons | [a] | [a] | [a] | [a] |
| Gems and precious stones | | 5,538 | | [a] |
| Gold.....troy ounces | 160,255 | 3,312,757 | 159,511 | 3,297,384 |
| Graphite, amorphous.....short tons | [a] | [a] | [a] | [a] |
| Gypsum.....do | 178,275 | 1,533,037 | 276,859 | 2,043,974 |
| Iron ore: | | | | |
| Sold to furnaces.....long tons | | | 25 | [a] |
| Sold for paint.....do | 268 | [a] | 26 | [a] |
| Lead.....short tons | 3,594 | 323,495 | 4,695 | 516,405 |
| Lime.....do | [a] | [a] | [a] | [a] |
| Manganese ore.....long tons | | | [a] | [a] |
| Manganiferous ore (for fluxing).....do | 14,871 | [a] | | |
| Mineral waters.....gallons sold | [a] | [a] | [a] | [a] |
| Pebbles for grinding.....short tons | [a] | [a] | | |
| Quicksilver.....flasks | [a] | [a] | [a] | [a] |
| Sand and gravel.....short tons | 153,285 | 34,862 | 278,356 | 89,991 |
| Silver.....troy ounces | 7,083,782 | 7,083,782 | 8,619,587 | 8,619,587 |
| Stone.....short tons | [a] | [a] | [a] | [a] |
| Sulphur.....long tons | [a] | [a] | [a] | [a] |
| Zinc.....short tons | 35 | 3,470 | 1,309 | 149,266 |
| Miscellaneous [d] | | 320,098 | | 536,290 |
| Total value, eliminating duplications | | 14,038,071 | | 18,374,023 |

[a] Value included under "Miscellaneous."
[b] Figures obtained through cooperation with Bureau of the Census.
[c] Value not included in total value for State.
[d] Includes minerals indicated by "a" above.

*Mineral production of New Hampshire in 1921 and 1922.*

| Product. | 1921 | | 1922 | |
|---|---|---|---|---|
| | Quantity. | Value. | Quantity. | Value. |
| Clay products | | [a b] $436,724 | | [a] $603,322 |
| Diatomaceous earth.....short tons | | | [c] | [c] |
| Feldspar (crude).....long tons | [c] | [c] | 14,017 | 116,751 |
| Fluorspar.....short tons | 567 | 13,721 | 690 | 15,353 |
| Garnet, abrasive.....do | [c] | [c] | [c] | [c] |
| Mica: | | | | |
| Scrap.....short tons | 537 | 10,613 | 238 | 5,838 |
| Sheet.....pounds | 491,743 | 63,249 | 475,647 | 63,240 |
| Millstones | | [c] | | |
| Mineral waters.....gallons sold | 225,720 | 9,599 | [c] | [c] |
| Peat.....short tons | [c] | [c] | 50 | 50 |
| Sand and gravel.....do | 368,562 | 303,476 | 442,509 | 357,900 |
| Scythestones.....do | [c] | [c] | [c] | [c] |
| Stone.....do | 89,460 | 1,338,277 | 128,650 | 1,071,556 |
| Miscellaneous [d] | | 58,348 | | 49,109 |
| Total value, eliminating duplications | | 2,234,007 | | 2,283,119 |

[a] Figures obtained through cooperation with Bureau of the Census.
[b] Exclusive of pottery, value for which is included under "Miscellaneous."
[c] Value included under "Miscellaneous."
[d] Includes minerals indicated by "b" and "c" above.

*Mineral production of New Jersey in 1921 and 1922.*

| Product. | 1921 | | 1922 | |
|---|---|---|---|---|
| | Quantity. | Value. | Quantity. | Value. |
| Briquets, fuel ---- short tons | (a b) | (a b) | (a b) | (a b) |
| Cement ---- barrels | 2,840,699 | $4,820,538 | (a) | (a) |
| Clay products | | c 27,214,685 | | c $38,124,888 |
| Clay, raw ---- short tons | 263,178 | b 1,049,748 | 313,360 | b 1,206,947 |
| Coke ---- do | 739,768 | (a b) | 790,811 | (a b) |
| Ferroalloys ---- long tons | (a b) | (a b) | (a b) | (a b) |
| Iron ore: | | | | |
| Sold to furnaces ---- do | 115,132 | 551,688 | 90,374 | 400,356 |
| Sold for paint ---- do | (a) | (a) | | |
| Iron, pig ---- do | (a b) | (a b) | 88,908 | (a b) |
| Lime ---- short tons | 1,818 | 14,365 | 2,392 | 20,845 |
| Manganiferous residuum d ---- long tons | 12,627 | (a) | 81,333 | (a) |
| Marl, greensand ---- short tons | 2,058 | 10,200 | 7,885 | 56,800 |
| Mineral paints, zinc and lead pigments ---- do | (a b) | (a b) | (a b) | (a b) |
| Mineral waters ---- gallons sold | 250,295 | 25,960 | 290,808 | 30,800 |
| Peat ---- short tons | 12,051 | 94,269 | 39,095 | 193,940 |
| Sand and gravel ---- do | 3,568,780 | 2,436,298 | 4,854,433 | 3,425,013 |
| Sand and sandstone (finely ground) ---- do | (a) | (a) | (a) | (a) |
| Slate | | (a) | | (a) |
| Stone ---- short tons | e 1,680,940 | e 2,634,738 | 1,903,840 | 2,850,557 |
| Sulphuric acid f ---- do | (a c) | (a c) | (f) | (f) |
| Talc ---- do | (a) | (a) | (a) | (a) |
| Zinc ---- do | 56,447 | (a) | 73,657 | (a) |
| Miscellaneous g | | 17,055,005 | | 27,322,876 |
| Total value, eliminating duplications | | 47,429,290 | | 62,396,379 |

a Value included under "Miscellaneous."
b Value not included in total value for State.
c Figures obtained through cooperation with Bureau of the Census.
d Ore mined in New Jersey; smelted in Pennsylvania.
e Exclusive of serpentine, value for which is included under "Miscellaneous."
f From copper smelting. No canvass for 1922.
g Includes minerals indicated by "a" and "e" above.

*Mineral production of New Mexico in 1921 and 1922.*

| Product. | 1921 | | 1922 | |
|---|---|---|---|---|
| | Quantity. | Value. | Quantity. | Value. |
| Clay products | | a $267,698 | | (a b) |
| Clay, raw ---- short tons | (b c) | (b c) | 1,681 | c $6,542 |
| Coal ---- do | d 2,453,482 | d 9,585,000 | 3,147,173 | 10,977,000 |
| Coke ---- do | (b c) | (b c) | 87,631 | c 788,679 |
| Copper ---- pounds | 14,267,338 | 1,840,487 | 31,937,207 | 4,311,523 |
| Fluorspar ---- short tons | 3,507 | 60,186 | 2,180 | 30,992 |
| Gems and precious stones | | (b) | | (b) |
| Gold ---- troy ounces | 9,521 | 196,822 | 19,964 | 412,693 |
| Gypsum ---- short tons | (b) | (b) | (b) | (b) |
| Iron ore ---- long tons | 110,528 | 244,284 | 118,038 | (b) |
| Lead ---- short tons | 339 | 30,537 | 1,506 | 165,672 |
| Lime ---- do | 3,044 | 33,660 | 3,587 | 38,520 |
| Lithium minerals ---- do | (b) | (b) | (b) | (b) |
| Manganiferous ore: | | | | |
| For fluxing ---- long tons | 300 | (b) | 8,764 | (b) |
| For other purposes ---- do | | | 28,623 | (b) |
| Mica, scrap ---- short tons | (b) | (b) | (b) | (b) |
| Mineral paints, zinc and lead pigments ---- do | (b c) | (b c) | (b c) | (b c) |
| Mineral waters ---- gallons sold | (b) | (b) | (b) | (b) |
| Petroleum ---- barrels | (b) | (b) | (b) | (b) |
| Salt ---- short tons | (b) | (b) | 718 | 5,747 |
| Sand and gravel ---- do | 327,345 | 168,895 | 244,315 | 146,670 |
| Silver ---- troy ounces | 571,899 | 571,899 | 752,240 | 752,240 |
| Stone ---- short tons | 39,640 | 52,356 | 366,300 | 224,525 |
| Zinc ---- do | 114 | 11,400 | 2,248 | 256,318 |
| Miscellaneous e | | 474,656 | | 952,193 |
| Total value, eliminating duplications | | 13,227,268 | | 18,038,022 |

a Figures obtained through cooperation with Bureau of the Census.
b Value included under "Miscellaneous."
c Value not included in total value for State.
d Exclusive of 3,460 tons produced at small mines, value for which is included under "Miscellaneous."
e Includes minerals indicated by "b" and "d" above.

*Mineral production of New York in 1921 and 1922.*

| Product. | | 1921 | | 1922 | |
|---|---|---|---|---|---|
| | | Quantity. | Value. | Quantity. | Value. |
| Aluminum | pounds | [a b] | [a b] | [a b] | [a b] |
| Briquets, fuel | short tons | [a b] | [a b] | | |
| Cement | barrels | [c] 4,993,341 | [c] $9,403,015 | [c] 6,194,663 | [c] $10,694,426 |
| Clay products | | | [d] 17,432,086 | | [d] 20,548,809 |
| Clay, raw | short tons | 4,247 | [b] 16,423 | 5,976 | [b] 20,463 |
| Coke | do | 746,916 | [b] 5,451,865 | 1,494,992 | [b] 11,865,785 |
| Diatomaceous earth | do | [a] | [a] | [a] | [a] |
| Emery | do | [a] | [a] | [a] | [a] |
| Feldspar (crude) | long tons | [a] | [a] | [a] | [a] |
| Ferroalloys | do | 29,401 | [b] 2,377,776 | 88,585 | [b] 7,373,187 |
| Garnet, abrasive | short tons | 2,998 | 258,705 | [a] | [a] |
| Graphite: | | | | | |
| Artificial | pounds | 5,888,000 | [a b] | 13,031,926 | [a b] |
| Crystalline | do | [a] | [a] | | |
| Gypsum | short tons | 712,665 | 6,410,221 | 1,055,302 | 8,807,366 |
| Iron ore: | | | | | |
| Sold to furnaces | long tons | 174,368 | 946,366 | 191,195 | 1,049,050 |
| Sold for paint | do | 2,445 | [a] | 14,769 | [a] |
| Iron, pig | do | 786,713 | [b] 18,212,810 | 1,708,605 | [b] 37,783,073 |
| Lime | short tons | 67,685 | 759,299 | 96,320 | 957,079 |
| Marl, calcareous | do | 800 | 4,928 | 1,300 | 8,125 |
| Millstones | | | 14,672 | | 17,025 |
| Mineral waters | gallons sold | 5,965,049 | 736,173 | 6,965,638 | 800,831 |
| Natural gas | M cubic feet | 6,583,000 | 2,798,000 | 6,947,000 | 3,379,000 |
| Natural-gas gasoline | gallons | 366,240 | 52,108 | 506,200 | 61,415 |
| Peat | short tons | 840 | 7,200 | 840 | 4,050 |
| Petroleum | barrels | 988,000 | 3,262,000 | 1,000,000 | 3,144,000 |
| Potash ($K_2O$) | short tons | [a] | [a] | | |
| Pyrites | long tons | [a] | [a] | 5,000 | [a] |
| Salt | short tons | 1,455,014 | 6,505,041 | 1,960,867 | 7,066,409 |
| Sand and gravel | do | 6,021,229 | 3,673,127 | 8,303,392 | 5,085,312 |
| Sand-lime brick | thousands | [a d] | [a d] | [e] | [e] |
| Silica (quartz) | short tons | [a] | [a] | [a] | [a] |
| Slate | | | 516,956 | | 642,972 |
| Stone | short tons | 5,809,140 | 8,705,331 | [f] 6,463,770 | [f] 8,744,124 |
| Talc | do | 37,489 | 464,645 | 71,479 | 1,116,914 |
| Zinc | do | 1,572 | 157,200 | 4,816 | 549,024 |
| Miscellaneous [g] | | | 6,616,311 | | 9,633,519 |
| Total value, eliminating duplications | | | 62,502,458 | | 73,527,880 |

[a] Value included under "Miscellaneous."
[b] Value not included in total value for State.
[c] Exclusive of natural cement, value for which is included under "Miscellaneous."
[d] Figures obtained through cooperation with Bureau of the Census.
[e] No canvass for 1922.
[f] Exclusive of unclassified stone, value for which is included under "Miscellaneous."
[g] Includes minerals indicated by "a," "e," and "f" above.

*Mineral production of North Carolina in 1921 and 1922.*

| Product. | | 1921 | | 1922 | |
|---|---|---|---|---|---|
| | | Quantity. | Value. | Quantity. | Value. |
| Aluminum | pounds | [a b] | [a b] | [a b] | [a b] |
| Barytes | short tons | [a] | [a] | [a] | [a] |
| Clay products | | | [c] $2,289,523 | | [c] $3,012,310 |
| Clay, raw | short tons | 11,712 | [b] 188,862 | 14,656 | [b] 214,622 |
| Coal | do | 23,438 | 135,000 | 78,570 | 388,000 |
| Feldspar (crude) | long tons | 40,712 | 259,603 | 56,043 | 333,745 |
| Gems and precious stones | | | [a] | | [a] |
| Gold | troy ounces | 154 | 3,179 | 94 | 1,939 |
| Iron ore | long tons | 383 | [a] | 19,279 | 49,415 |
| Lime | short tons | [a] | [a] | [a] | [a] |
| Marl, calcareous | do | 1,482 | 4,446 | [a] | [a] |
| Mica: | | | | | |
| Scrap | do | 1,353 | 30,496 | 4,205 | 65,923 |
| Sheet | pounds | 230,532 | 51,851 | 544,495 | 119,767 |
| Millstones | | | [a] | | [a] |
| Mineral waters | gallons sold | 87,052 | 13,561 | 65,020 | 9,941 |
| Peat | short tons | [a] | [a] | 400 | 8,000 |
| Sand and gravel | do | 711,382 | 485,834 | 764,940 | 634,924 |
| Silica (quartz) | do | [a] | [a] | | |
| Silver | troy ounces | 18 | 18 | 9 | 9 |
| Stone | short tons | 730,690 | 2,087,879 | [d] 948,810 | [d] 2,483,851 |
| Talc | do | 731 | 17,048 | 2,194 | 23,049 |
| Miscellaneous [e] | | | 2,793,635 | | 3,556,630 |
| Total value, eliminating duplications | | | 5,456,479 | | 7,268,381 |

[a] Value included under "Miscellaneous."
[b] Value not included in total value for State.
[c] Figures obtained through cooperation with Bureau of the Census.
[d] Exclusive of marble, value for which is included under "Miscellaneous."
[e] Includes minerals indicated by "a" and "d" above.

*Mineral production of North Dakota in 1921 and 1922.*

| Product. | 1921 | | 1922 | |
|---|---|---|---|---|
| | Quantity. | Value. | Quantity. | Value. |
| Clay products | | [a] $160,949 | | [a] $173,715 |
| Clay, raw, short tons | 16 | [b] 183 | 45 | [b] 474 |
| Coal, do | 864,903 | 2,329,500 | 1,327,564 | 3,513,000 |
| Mineral waters, gallons sold | 585,000 | 8,100 | [c] | [c] |
| Natural gas, M cubic feet | 1,000 | 400 | 600 | 300 |
| Sand and gravel, short tons | [c] | [c] | [c] | [c] |
| Miscellaneous [d] | | 1,400 | | 6,080 |
| Total value, eliminating duplications | | 2,500,349 | | 3,693,095 |

[a] Figures obtained through cooperation with Bureau of the Census.
[b] Value not included in total value for State.
[c] Value included under "Miscellaneous."
[d] Includes minerals indicated by "c" above.

*Mineral production of Ohio in 1921 and 1922.*

| Product. | 1921 | | 1922 | |
|---|---|---|---|---|
| | Quantity. | Value. | Quantity. | Value. |
| Bromine, pounds | | | [a] | [a] |
| Calcium chloride, short tons | 1,030 | $18,854 | [a] | [a] |
| Cement, barrels | [b] 2,518,723 | [b] 4,615,492 | [b] 2,913,034 | [b] $5,243,687 |
| Clay products | | [c] 67,396,680 | | [c] 71,347,314 |
| Clay, raw, short tons | 150,902 | [d] 277,514 | 235,684 | [d] 448,677 |
| Coal, do | 31,942,776 | 84,686,500 | 26,953,791 | 87,056,000 |
| Coke, do | 3,028,423 | [d] 16,272,453 | 5,011,138 | [d] 33,100,323 |
| Ferroalloys, long tons | 17,490 | [d] 566,780 | 55,383 | [d] 1,906,815 |
| Grindstones and pulpstones, short tons | 19,987 | 870,130 | 22,616 | 787,591 |
| Gypsum, do | 363,905 | 3,191,937 | 435,485 | 3,976,100 |
| Iron, pig, long tons | 3,649,835 | [d] 88,473,082 | 6,756,648 | [d] 149,805,909 |
| Lime, short tons | 471,053 | 4,224,579 | 752,916 | 6,495,066 |
| Marl, calcareous, do | [a] | [a] | [a] | [a] |
| Mineral paints, zinc and lead pigments, do | [a d] | [a d] | [a d] | [a d] |
| Mineral waters, gallons sold | 2,219,149 | 161,208 | 2,298,132 | 162,814 |
| Natural gas, M cubic feet | 47,412,000 | 19,216,000 | 51,481,000 | 24,181,000 |
| Natural-gas gasoline, gallons | 9,099,897 | 1,546,551 | 8,600,296 | 1,300,929 |
| Oilstones and scythestones, short tons | 309 | 38,317 | [a] | [a] |
| Petroleum, barrels | 7,335,000 | 21,512,000 | 6,781,000 | 17,369,000 |
| Salt, short tons | 749,349 | 3,284,952 | 1,105,757 | 3,749,564 |
| Sand and gravel, do | 5,138,276 | 4,060,486 | 6,999,962 | 5,503,374 |
| Sand-lime brick, thousands | [a c] | [a c] | [e] | [e] |
| Stone, short tons | 7,229,150 | 8,563,522 | 9,137,480 | 9,564,640 |
| Sulphuric acid [f], do | [a c] | [a c] | [e] | [e] |
| Miscellaneous [g] | | 587,636 | | 1,471,724 |
| Total value, eliminating duplications | | 223,533,658 | | 236,808,638 |

[a] Value included under "Miscellaneous."
[b] Exclusive of natural cement, value for which is included under "Miscellaneous."
[c] Figures obtained through cooperation with Bureau of the Census.
[d] Value not included in total value for State.
[e] No canvass for 1922.
[f] From zinc smelting.
[g] Includes minerals indicated by "a" and "b" above.

*Mineral production of Oklahoma in 1921 and 1922.*

| Product. | 1921 | | 1922 | |
|---|---|---|---|---|
| | Quantity. | Value. | Quantity. | Value. |
| Asphalt short tons | 151, 134 | $1, 446, 083 | 48, 597 | $184, 035 |
| Cement barrels | 1, 596, 566 | 3, 420, 093 | [a] | [a] |
| Clay products | | [b] 1, 796, 666 | | [b] 1, 935, 570 |
| Coal short tons | 3, 362, 623 | 15, 546, 000 | 2, 802, 511 | 11, 527, 000 |
| Gypsum do | 209, 201 | 1, 289, 226 | 242, 932 | 1, 651, 837 |
| Lead do | 41, 552 | 3, 739, 680 | 62, 856 | 6, 914, 160 |
| Lime do | [a] | [a] | [a] | [a] |
| Mineral paints, zinc and lead pigments do | [a c] | [a c] | [a c] | [a c] |
| Mineral waters gallons sold | 1, 319, 895 | 45, 078 | 1, 434, 885 | 46, 047 |
| Natural gas M cubic feet | 124, 058, 000 | 23, 429, 000 | 140, 631, 000 | 33, 475, 800 |
| Natural-gas gasoline gallons | 185, 340, 742 | 22, 066, 014 | 189, 403, 670 | 24, 914, 048 |
| Petroleum barrels | 114, 634, 000 | 183, 185, 000 | 149, 571, 000 | 258, 160, 000 |
| Sand and gravel short tons | 881, 849 | 686, 507 | 1, 357, 272 | 903, 013 |
| Stone do | [d] 878, 350 | [d] 1, 023, 514 | 1, 156, 950 | 1, 327, 370 |
| Tripoli do | [a] | [a] | [a] | [a] |
| Zinc do | 121, 372 | 12, 137, 200 | 209, 682 | 23, 903, 748 |
| Miscellaneous [e] | | 161, 375 | | 4, 283, 343 |
| Total value, eliminating duplications | | 269, 882, 786 | | 369, 069, 612 |

[a] Value included under "Miscellaneous."
[b] Figures obtained through cooperation with Bureau of the Census.
[c] Value not included in total value for State.
[d] Exclusive of sandstone, value for which is included under "Miscellaneous."
[e] Includes minerals indicated by "a" and "d" above.

*Mineral production of Oregon in 1921 and 1922.*

| Product. | 1921 | | 1922 | |
|---|---|---|---|---|
| | Quantity. | Value. | Quantity. | Value. |
| Briquets, fuel short tons | [a b] | [a b] | [a b] | [a b] |
| Cement barrels | [a] | [a] | [a] | [a] |
| Chromite long tons | 159 | $1, 614 | 79 | $632 |
| Clay products | | [c d] 471, 472 | | [c d] 569, 289 |
| Clay, raw short tons | 224 | [b] 857 | 3, 288 | [b] 9, 527 |
| Coal do | [a] | [a] | [a] | [a] |
| Copper pounds | 174, 300 | 22, 485 | 1, 046, 525 | 141, 281 |
| Diatomaceous earth short tons | [a] | [a] | [a] | [a] |
| Gems and precious stones | | [a] | | [a] |
| Gold troy ounces | 42, 568 | 882, 034 | 25, 715 | 531, 568 |
| Gypsum short tons | [a] | [a] | [a] | [a] |
| Lead do | | | 38 | 4, 243 |
| Lime do | [a] | [a] | [a] | [a] |
| Mineral waters gallons sold | 2, 150 | 653 | 2, 621 | 598 |
| Natural gas M cubic feet | 200 | 100 | | |
| Platinum and allied metals troy ounces | 73 | 6, 830 | 78 | 9, 536 |
| Quicksilver flasks | [a] | [a] | 2 | 116 |
| Sand and gravel short tons | 1, 351, 425 | 1, 079, 815 | 1, 524, 827 | 1, 178, 278 |
| Silver troy ounces | 42, 120 | 42, 120 | 151, 812 | 151, 812 |
| Stone short tons | 804, 550 | 1, 074, 596 | 661, 070 | 897, 784 |
| Miscellaneous [e] | | 2, 191, 582 | | 2, 831, 397 |
| Total value, eliminating duplications | | 5, 199, 803 | | 5, 489, 956 |

[a] Value included under "Miscellaneous."
[b] Value not included in total value for State.
[c] Exclusive of pottery, value for which is included under "Miscellaneous."
[d] Figures obtained through cooperation with Bureau of the Census.
[e] Includes minerals indicated by "a" and "c" above.

*Mineral production of Pennsylvania in 1921 and 1922.*

| Product. | 1921 | | 1922 | |
|---|---|---|---|---|
| | Quantity. | Value. | Quantity. | Value. |
| Briquets, fuel short tons | 66,352 | [a] $407,570 | 114,158 | [a] $676,970 |
| Cement barrels | [b] 26,622,367 | [b] 46,881,625 | [b] 34,023,695 | [b] 55,528,002 |
| Clay products | | [c] 32,164,172 | | [c] 41,683,044 |
| Clay, raw short tons | 254,179 | [a] 895,394 | 381,259 | [a] 1,306,253 |
| Coal: | | | | |
| Anthracite do | 90,473,451 | 452,304,903 | 54,683,022 | 273,700,125 |
| Bituminous do | 116,013,942 | 322,538,300 | 113,148,308 | 351,777,000 |
| Coke do | 9,769,476 | [a] 44,111,831 | 13,991,892 | [a] 74,794,560 |
| Copper pounds | 313,302 | 40,416 | 1,229,926 | 166,040 |
| Feldspar (crude) long tons | [d] | [d] | [d] | [d] |
| Ferroalloys do | 161,198 | [a] 14,581,323 | 206,966 | [a] 14,148,302 |
| Fuller's earth short tons | | | [d] | [d] |
| Gems and precious stones | | [d] | | [d] |
| Gold troy ounces | | | 126 | 2,600 |
| Iron ore: | | | | |
| Sold to furnaces long tons | 187,062 | 288,955 | 782,916 | 1,022,756 |
| Sold for paint do | 2,709 | [d] | 3,256 | [d] |
| Iron, pig do | 6,072,196 | [a] 148,350,285 | 9,732,024 | [a] 221,581,288 |
| Lime short tons | 509,891 | 4,247,509 | 719,536 | 5,581,794 |
| Marl, calcareous do | 1,000 | 6,590 | [d] | [d] |
| Mineral paints, zinc and lead pigments do | [a d] | [a d] | [a d] | [a d] |
| Mineral waters gallons sold | 730,252 | 74,490 | 824,988 | 81,435 |
| Naturas gas M cubic feet | 86,144,000 | 32,815,000 | 101,276,000 | 39,835,000 |
| Natural-gas gasoline gallons | 19,856,373 | 3,354,233 | 18,518,131 | 3,144,545 |
| Petroleum barrels | 7,418,000 | 24,746,000 | 7,425,000 | 23,834,000 |
| Potash ($K_2O$) short tons | 47 | 4,717 | [d] | [d] |
| Pyrites long tons | [d] | [d] | | |
| Sand and gravel short tons | 6,640,334 | 7,600,711 | 7,352,988 | 7,413,686 |
| Sand and sandstone (finely ground) do | [d] | [d] | [d] | [d] |
| Sand-lime brick thousands | [a d] | [a d] | [•] | [•] |
| Silica (quartz) short tons | [d] | [d] | [d] | [d] |
| Silver troy ounces | | | 2,215 | 2,215 |
| Slate | | 3,595,386 | | 4,324,294 |
| Stone short tons | 9,022,650 | 12,378,202 | 12,731,940 | 14,591,194 |
| Sulphuric acid (60° Baumé) [f] do | [e g] 98,766 | [e g] 1,271,000 | [•] | [•] |
| Talc do | [d] | [d] | [d] | [d] |
| Tripoli (rottenstone) do | [d] | [d] | [d] | [d] |
| Miscellaneous [h] | | 10,339,646 | | 14,772,068 |
| Total value, eliminating duplications | | 944,688,650 | | 823,148,222 |

[a] Value not included in total value for State.
[b] Exclusive of natural cement, value for which is included under "Miscellaneous."
[c] Figures obtained through cooperation with Bureau of the Census.
[d] Value included under "Miscellaneous."
[•] No canvass for 1922.
[f] From zinc smelting.
[g] Figures represent production, the value having been partly estimated by Geological Survey to cover acid consumed by producer as well as that sold.
[h] Includes minerals indicated by "b" and "d" above.

*Mineral production of Rhode Island in 1921 and 1922.*

| Product. | 1921 | | 1922 | |
|---|---|---|---|---|
| | Quantity. | Value. | Quantity. | Value. |
| Clay products | | [a b] | | [a b] |
| Coke short tons | [a c] | [a c] | [a c] | [a c] |
| Graphite, amorphous do | [a] | [a] | [a] | [a] |
| Lime do | [a] | [a] | [a] | [a] |
| Mineral waters gallons sold | 327,352 | $21,391 | 279,109 | $25,704 |
| Sand and gravel short tons | 11,364 | 15,590 | 12,441 | 17,661 |
| Stone do | [d] 126,590 | [d] 609,999 | [d] 73,400 | [d] 357,635 |
| Miscellaneous [e] | | 1,391,599 | | 1,827,158 |
| Total value, eliminating duplications | | 922,765 | | 770,966 |

[a] Value included under "Miscellaneous."
[b] Figures obtained through cooperation with Bureau of the Census.
[c] Value not included in total value for State.
[d] Exclusive of limestone, value for which is included under "Miscellaneous."
[e] Includes minerals indicated by "a" and "d" above.

*Mineral production of South Carolina in 1921 and 1922.*

| Product. | 1921 | | 1922 | |
|---|---|---|---|---|
| | Quantity. | Value. | Quantity. | Value. |
| Barytes short tons | [a] | [a] | [a] | [a] |
| Clay products | | [b] $689,663 | | [b] [c] $884,513 |
| Clay, raw short tons | 35,891 | [d] 273,892 | 53,577 | [d] 416,725 |
| Gold troy ounces | 2 | 50 | 2 | 32 |
| Marl, calcareous short tons | [a] | [a] | | |
| Mica, scrap do | | | [a] | [a] |
| Mineral waters gallons sold | 124,055 | 18,489 | 96,900 | 21,622 |
| Phosphate rock long tons | | | 1,500 | 8,250 |
| Sand and gravel short tons | 330,669 | 154,661 | 422,750 | 297,898 |
| Stone do | 427,140 | 882,267 | 638,400 | 1,175,049 |
| Miscellaneous [e] | | 9,361 | | 26,982 |
| Total value, eliminating duplications | | 1,754,491 | | 2,414,346 |

[a] Value included under "Miscellaneous."
[b] Figures obtained through cooperation with Bureau of the Census.
[c] Exclusive of pottery, value for which is included under "Miscellaneous."
[d] Value not included in total value for State.
[e] Includes minerals indicated by "[a]" and "[c]" above.

*Mineral production of South Dakota in 1921 and 1922.*

| Product. | 1921 | | 1922 | |
|---|---|---|---|---|
| | Quantity. | Value. | Quantity. | Value. |
| Clay products | | [a] [b] | | [a] [b] |
| Clay, raw short tons | 900 | [c] $9,000 | 100 | [c] $1,000 |
| Coal do | 7,553 | 21,200 | 7,752 | 22,000 |
| Columbite pounds | 3,400 | 1,150 | 600 | 240 |
| Gems and precious stones | | 335 | | [b] |
| Gold troy ounces | 319,525 | 6,605,167 | 315,298 | 6,517,788 |
| Gypsum short tons | [b] | [b] | [b] | [b] |
| Lead do | 2 | 180 | | |
| Lime do | [b] | [b] | 3,852 | 43,990 |
| Lithium minerals do | [b] | [b] | [b] | [b] |
| Mica, scrap do | 92 | 2,290 | [b] | [b] |
| Mineral waters gallons sold | [b] | [b] | 796,500 | 32,850 |
| Natural gas M cubic feet | 9,700 | 4,000 | 15,600 | 6,400 |
| Sand and gravel short tons | 185,639 | 136,152 | 200,408 | 121,690 |
| Sand-lime brick thousands | [a] [b] | [a] [b] | [d] | [d] |
| Silver troy ounces | 112,464 | 112,464 | 118,760 | 118,760 |
| Stone short tons | 181,600 | 386,906 | 133,920 | 272,152 |
| Miscellaneous [e] | | 228,812 | | 143,064 |
| Total value, eliminating duplications | | 7,498,656 | | 7,278,934 |

[a] Figures obtained through cooperation with Bureau of the Census.
[b] Value included under "Miscellaneous."
[c] Value not included in total value for State.
[d] No canvass for 1922.
[e] Includes minerals indicated by "[b]" above.

*Mineral production of Tennessee in 1921 and 1922.*

| Product. | | 1921 | | 1922 | |
|---|---|---|---|---|---|
| | | Quantity. | Value. | Quantity. | Vale. |
| Aluminum | pounds | [a b] | [a b] | [a b] | [a b] |
| Barytes | short tons | 8,180 | $61,148 | 16,642 | $124,204 |
| Bauxite | long tons | [a] | [a] | [a] | [a] |
| Cement | barrels | [a] | [a] | [a] | [a] |
| Clay products | | | [c] 2,971,448 | | [c] 4,278,270 |
| Clay, raw | short tons | 52,929 | [b] 287,409 | 74,114 | [b] 362,281 |
| Coal | do | 4,460,326 | 14,932,000 | 4,876,774 | 14,096,000 |
| Coke | do | 85,728 | [b] 459,469 | 113,896 | [b] 820,878 |
| Copper | pounds | 15,084,294 | 1,945,874 | 14,240,571 | 1,922,477 |
| Ferroalloys | long tons | 13,808 | [b] 780,713 | [a b] | [a b] |
| Gold | troy ounces | 238 | 4,920 | 209 | 4,320 |
| Iron ore: | | | | | |
| Sold to furnaces | long tons | 25,219 | 68,726 | 159,473 | 418,578 |
| Sold for paint | do | [a] | [a] | 700 | [a] |
| Iron, pig | do | 21,972 | [b] 595,850 | 95,326 | [b] 2,063,376 |
| Lead | short tons | | | 732 | 80,520 |
| Lime | do | 93,397 | 733,639 | 126,305 | 939,039 |
| Manganese ore | long tons | 139 | 3,396 | 113 | 1,636 |
| Manganiferous ore | do | 24 | 257 | | |
| Mineral waters | gallons sold | 1,150,585 | 72,227 | 1,005,119 | 67,838 |
| Natural gas | M cubic feet | 11,000 | 2,600 | 3,000 | 800 |
| Petroleum | barrels | 12,400 | 21,400 | 9,800 | 17,000 |
| Phosphate rock | long tons | 264,159 | 1,720,819 | 339,027 | 2,003,342 |
| Potash ($K_2O$) | short tons | [a] | [a] | | |
| Pyrites | long tons | [a] | [a] | | |
| Sand and gravel | short tons | 1,095,114 | 930,767 | 1,571,492 | 1,193,133 |
| Sand and sandstone (finely ground) | do | | | [a] | [a] |
| Sand-lime brick | thousands | [a c] | [a c] | [d] | [d] |
| Silver | troy ounces | 98,762 | 98,762 | 78,341 | 78,341 |
| Slate | | | [a] | | [a] |
| Stone | short tons | [e] 940,170 | [e] 2,707,025 | [e] 1,091,530 | [e] 3,759,876 |
| Sulphuric acid [f] | do | [a c] | [a c] | [d] | [d] |
| Zinc | do | 9,692 | 969,200 | 15,568 | 1,774,752 |
| Miscellaneous [g] | | | 8,909,935 | | 7,733,704 |
| Total value, eliminating duplications | | | 33,754,823 | | 35,146,266 |

[a] Value included under "Miscellaneous."
[b] Value not included in total value for State.
[c] Figures obtained through cooperation with Bureau of the Census.
[d] No canvass for 1922.
[e] Exclusive of sandstone, value for which is included under "Miscellaneous."
[f] From copper smelting.
[g] Includes minerals indicated by "a" and "e" above.

*Mineral production of Texas in 1921 and 1922.*

| Product. | | 1921 | | 1922 | |
|---|---|---|---|---|---|
| | | Quantity. | Value. | Quantity. | Value. |
| Asphalt | short tons | 270,761 | $2,870,583 | 340,334 | $3,414,837 |
| Cement | barrels | 2,514,045 | 5,902,863 | 3,730,477 | 7,515,932 |
| Clay products | | | [a] 3,976,136 | | [a] 4,376,401 |
| Clay, raw | short tons | 2,370 | [b] 11,099 | 3,554 | [b] 22,601 |
| Coal | do | 972,839 | 2,563,600 | 1,106,007 | 2,563,000 |
| Copper | pounds | | | 4,290 | 579 |
| Fuller's earth | short tons | 8,797 | 127,408 | 12,285 | 123,536 |
| Gems and precious stones | | | [c] | | [c] |
| Graphite, crystalline | pounds | [c] | [c] | [c] | [c] |
| Gypsum | short tons | 232,806 | 1,765,600 | 221,914 | 2,081,479 |
| Iron ore | long tons | 131 | [c] | | |
| Lead | short tons | | | 4 | 441 |
| Lime | do | 44,404 | 452,078 | 52,552 | 524,985 |
| Mineral waters | gallons sold | 366,429 | 67,410 | 307,478 | 50,737 |
| Natural gas | M cubic feet | 44,504,000 | 8,893,000 | 47,945,000 | 10,623,000 |
| Natural-gas gasoline | gallons | 77,141,201 | 9,118,420 | 95,405,483 | 12,114,952 |
| Petroleum | barrels | 106,166,000 | 162,663,000 | 118,684,000 | 189,175,000 |
| Quicksilver | flasks | [c] | [c] | [c] | [c] |
| Salt | short tons | [c] | [c] | [c] | [c] |
| Sand and gravel | do | 2,970,568 | 1,847,741 | 2,939,105 | 1,730,046 |
| Sand-lime brick | thousands | [a c] | [a c] | [d] | [d] |
| Silver | troy ounces | 516,766 | 516,766 | 644,980 | 644,980 |
| Stone | short tons | 1,045,320 | 1,242,806 | 1,335,660 | 1,314,203 |
| Sulphur | long tons | [c] | [c] | [c] | [c] |
| Miscellaneous [e] | | | 10,295,496 | | 13,350,065 |
| Total value, eliminating duplications | | | 212,302,907 | | 249,604,173 |

[a] Figures obtained through cooperation with Bureau of the Census.
[b] Value not included in total value for State.
[c] Value included under "Miscellaneous."
[d] No canvass for 1922.
[e] Includes minerals indicated by "c" above.

*Mineral production of Utah in 1921 and 1922.*

| Product. | 1921 | | 1922 | |
|---|---|---|---|---|
| | Quantity. | Value. | Quantity. | Value. |
| Asphalt short tons | 10,371 | $190,808 | 29,704 | $623,207 |
| Cement barrels | [a] | [a] | [a] | [a] |
| Clay products | | [b] [c] 1,057,678 | | [b] [c] 860,433 |
| Clay, raw short tons | 3,086 | [d] 13,791 | 4,567 | [d] 20,754 |
| Coal do | [e] 4,078,784 | [c] 13,662,000 | 4,992,008 | 15,687,500 |
| Coke do | [a] [d] | [a] [d] | 172,453 | [d] 1,406,109 |
| Copper pounds | 30,891,403 | 3,984,991 | 97,193,850 | 13,121,170 |
| Diatomaceous earth short tons | [a] | [a] | [a] | [a] |
| Fluorspar do | | | [a] | [a] |
| Gems and precious stones | | 820 | | [a] |
| Gold troy ounces | 85,619 | 1,769,905 | 111,110 | 2,296,855 |
| Gypsum short tons | 35,536 | 243,222 | 48,338 | 304,562 |
| Iron ore long tons | 60,773 | 156,865 | 15,018 | 63,806 |
| Lead short tons | 44,594 | 4,013,427 | 67,666 | 7,443,268 |
| Lime do | 7,972 | 104,605 | 11,082 | 147,087 |
| Mineral paints, zinc and lead pigments do | | | [a] [d] | [a] [d] |
| Potash ($K_2O$) do | 1,470 | 153,644 | 536 | 25,711 |
| Salt do | 68,874 | 491,354 | 81,909 | 387,093 |
| Sand and gravel do | 527,403 | 162,944 | 412,544 | 152,469 |
| Silver troy ounces | 12,251,998 | 12,251,998 | 17,271,100 | 17,271,100 |
| Sodium sulphate from natural sources short tons | [a] | [a] | [a] | [a] |
| Stone do | [f] 374,010 | [f] 483,773 | 411,590 | 380,246 |
| Sulphur long tons | [a] | [a] | [a] | [a] |
| Sulphuric acid [g] short tons | [a] [c] | [a] [c] | [a] | [a] |
| Uranium and vanadium ores do | 53 | 5,440 | 338 | 92,141 |
| Zinc do | 35 | 3,469 | 2,560 | 291,806 |
| Miscellaneous [h] | | 3,132,601 | | 1,556,492 |
| Total value, eliminating duplications | | 40,595,872 | | 60,697,116 |

[a] Value included under "Miscellaneous."
[b] Exclusive of pottery, value for which is included under "Miscellaneous."
[c] Figures obtained through cooperation with Bureau of the Census.
[d] Value not included in total value for State.
[e] Exclusive of 11,611 tons produced at small mines, value for which is included under "Miscellaneous."
[f] Exclusive of marble, value for which is included under "Miscellaneous."
[g] From copper smelting. No canvass for 1922.
[h] Includes minerals indicated by "a," "b," "e," and "f" above.

*Mineral production of Vermont in 1921 and 1922.*

| Product. | 1921 | | 1922 | |
|---|---|---|---|---|
| | Quantity. | Value. | Quantity. | Value. |
| Asbestos short tons | | | [a] | [a] |
| Clay products | | [a] [b] | | [a] [b] |
| Clay, raw short tons | 2,560 | [c] $35,210 | [a] [c] | [a] [c] |
| Lime do | 32,782 | 460,318 | 44,745 | $565,498 |
| Mineral waters gallons sold | 4,500 | 468 | [a] | [a] |
| Sand and gravel short tons | 38,752 | 13,740 | 64,089 | 19,295 |
| Scythestones do | [a] | [a] | [a] | [a] |
| Slate | | 2,346,978 | | 2,907,858 |
| Stone short tons | 202,630 | 7,322,843 | 190,410 | 5,331,970 |
| Talc do | 48,648 | 438,534 | 75,485 | 654,715 |
| Miscellaneous [d] | | 67,332 | | 109,330 |
| Total value, eliminating duplications | | 10,650,213 | | 9,576,636 |

[a] Value included under "Miscellaneous."
[b] Figures obtained through cooperation with Bureau of the Census.
[c] Value not included in total value for State.
[d] Includes minerals indicated by "a" above.

*Mineral production of Virginia in 1921 and 1922.*

| Product. | 1921 | | 1922 | |
|---|---|---|---|---|
| | Quantity. | Value. | Quantity. | Value. |
| Barytes—short tons | [a] | [a] | | |
| Briquets, fuel—do | [a b] | [a b] | [a b] | [a b] |
| Cement—barrels | [a] | [a] | [a] | [a] |
| Clay products | | [c] $2,563,883 | | [c d] $2,845,510 |
| Clay, raw—short tons | 9,430 | [b] 92,730 | 13,810 | [b] 113,828 |
| Coal—do | 7,492,378 | 22,947,700 | 10,491,174 | 27,083,000 |
| Coke—do | 280,476 | [b] 2,029,652 | 378,656 | [b] 2,291,336 |
| Diatomaceous earth—do | [a] | [a] | [a] | [a] |
| Emery—do | [a] | [a] | [a] | [a] |
| Feldspar (crude)—long tons | | | 25 | 163 |
| Ferroalloys—do | [a b] | [a b] | [a b] | [a b] |
| Gold—troy ounces | 37 | 763 | 34 | 706 |
| Gypsum—short tons | [a] | [a] | [a] | [a] |
| Iron ore—long tons | 54,353 | 196,935 | 30,359 | 120,685 |
| Iron, pig—do | 66,916 | [b] 2,023,268 | 31,022 | [b] 793,903 |
| Lime—short tons | 111,518 | 1,005,677 | 152,436 | 1,251,683 |
| Manganese ore—long tons | 717 | 15,549 | 800 | [a] |
| Marl, calcareous—short tons | 33,978 | 105,821 | 28,971 | 57,887 |
| Mica: | | | | |
| Scrap—do | [a] | [a] | 296 | 9,718 |
| Sheet—pounds | [a] | [a] | 43,449 | 6,577 |
| Millstones | | [a] | | [a] |
| Mineral black—short tons | | | [a] | [a] |
| Mineral waters—gallons sold | 902,034 | 122,283 | 840,113 | 111,879 |
| Potash ($K_2O$)—short tons | [a] | [a] | | |
| Pyrites—long tons | [a] | [a] | [a] | [a] |
| Salt—short tons | [a] | [a] | [a] | [a] |
| Sand and gravel—do | 1,048,293 | 958,527 | 1,570,775 | 1,333,441 |
| Silver—troy ounces | 8 | 8 | 6 | 6 |
| Slate | | 212,943 | | [e] 312,652 |
| Stone—short tons | 1,379,300 | 1,557,668 | 1,626,740 | 1,801,778 |
| Talc and soapstone—do | 17,721 | 601,878 | 25,351 | 736,132 |
| Titanium minerals: | | | | |
| Ilmenite—do | | | 600 | [a] |
| Rutile—do | | | 310 | [a] |
| Miscellaneous [f] | | 2,845,657 | | 3,249,554 |
| Total value, eliminating duplications | | 32,810,842 | | 38,551,479 |

[a] Value included under "Miscellaneous."
[b] Value not included in total value for State.
[c] Figures obtained through cooperation with Bureau of the Census.
[d] Exclusive of pottery, value for which is included under "Miscellaneous."
[e] Exclusive of granules, value for which is included under "Miscellaneous."
[f] Includes minerals indicated by "[a]," "[d]," and "[e]" above.

*Mineral production of Washington in 1921 and 1922.*

| Product. | 1921 | | 1922 | |
|---|---|---|---|---|
| | Quantity. | Value. | Quantity. | Value. |
| Briquets, fuel—short tons | [a b] | [a b] | [a b] | [a b] |
| Cement—barrels | 1,612,891 | $4,080,785 | 1,951,414 | $4,684,624 |
| Clay products | | [c] 1,496,741 | | [c] 1,982,759 |
| Clay, raw—short tons | 439 | [b] 5,153 | 6,136 | [b] 14,745 |
| Coal—do | 2,428,722 | 9,787,060 | 2,581,165 | 10,279,000 |
| Coke—do | 27,260 | [b] 194,510 | 31,674 | [b] 285,881 |
| Copper—pounds | 251,544 | 32,449 | 317,203 | 42,822 |
| Diatomaceous earth—short tons | [a] | [a] | [a] | [a] |
| Ferroalloys—long tons | [a b] | [a b] | | |
| Gems and precious stones | | [a] | | |
| Gold—troy ounces | 6,216 | 128,486 | 9,044 | 186,965 |
| Lead—short tons | 72 | 6,460 | 691 | 75,966 |
| Lime—do | 17,710 | 209,761 | 25,447 | 355,412 |
| Magnesite—do | | | [a] | [a] |
| Mineral waters—gallons sold | [a] | [a] | [a] | [a] |
| Platinum—troy ounces | | | 3 | 306 |
| Sand and gravel—short tons | 1,481,574 | 881,842 | 1,802,121 | 844,252 |
| Silica (quartz)—do | [a] | [a] | | |
| Silver—troy ounces | 142,450 | 142,450 | 205,046 | 205,046 |
| Stone—short tons | 542,490 | 789,364 | [d] 647,160 | [d] 887,175 |
| Zinc—do | 225 | 22,468 | 614 | 70,009 |
| Miscellaneous [e] | | 159,088 | | 519,165 |
| Total value, eliminating duplications | | 17,605,878 | | 19,725,303 |

[a] Value included under "Miscellaneous."
[b] Value not included in total value for State.
[c] Figures obtained through cooperation with Bureau of the Census.
[d] Exclusive of sandstone, value for which is included under "Miscellaneous."
[e] Includes minerals indicated by "[a]" and "[d]" above.

*Mineral production of West Virginia in 1921 and 1922.*

| Product. | 1921 | | 1922 | |
|---|---|---|---|---|
| | Quantity. | Value. | Quantity. | Value. |
| Bromine ---- pounds | 49,717 | $5,081 | 117,931 | $12,147 |
| Calcium chloride ---- short tons | 2,959 | 48,467 | 6,121 | 63,442 |
| Cement ---- barrels | (a) | (a) | (a) | (a) |
| Clay products | | [b] 13,736,172 | | [b] 12,979,381 |
| Clay, raw ---- short tons | 25,244 | [c] 42,595 | 58,692 | [c] 91,371 |
| Coal ---- do | 72,786,996 | 206,661,500 | 80,488,192 | 236,162,000 |
| Coke ---- do | 397,892 | [c] 2,253,044 | 919,744 | [c] 6,112,387 |
| Ferroalloys ---- long tons | (a c) | (a c) | (a c) | (a c) |
| Grindstones and pulpstones ---- short tons | 5,497 | 330,582 | 2,896 | 263,616 |
| Iron, pig ---- long tons | 259,312 | [c] 6,557,498 | 309,944 | [c] 7,537,184 |
| Lime ---- short tons | 119,716 | 1,015,690 | 219,146 | 1,643,055 |
| Marl, calcareous ---- do | (a) | (a) | (a) | (a) |
| Mineral waters ---- gallons sold | 412,595 | 37,265 | 380,726 | 32,137 |
| Natural gas ---- M cubic feet | 174,920,800 | 52,827,900 | 195,288,000 | 69,464,000 |
| Natural-gas gasoline ---- gallons | 54,646,053 | 9,889,861 | 56,795,713 | 9,770,884 |
| Petroleum ---- barrels | 7,822,000 | 26,482,000 | 7,021,000 | 22,891,000 |
| Salt ---- short tons | 27,964 | 320,537 | 25,188 | 283,257 |
| Sand and gravel ---- do | 1,374,679 | 2,039,042 | 1,553,929 | 2,063,781 |
| Sand and sandstone (finely ground) ---- do | (a) | (a) | (a) | (a) |
| Stone ---- do | 1,609,200 | 1,702,097 | 2,163,470 | 2,134,944 |
| Sulphuric acid [d] ---- do | (a b) | (a b) | (d) | (d) |
| Miscellaneous [e] | | 1,348,285 | | 1,732,912 |
| Total value, eliminating duplications | | 316,180,647 | | 358,772,116 |

[a] Value included under "Miscellaneous."
[b] Figures obtained through cooperation with Bureau of the Census.
[c] Value not included in total value for State.
[d] From zinc smelting. No canvass for 1922.
[e] Includes minerals indicated by "a" above.

*Mineral production of Wisconsin in 1921 and 1922.*

| Product. | 1921 | | 1922 | |
|---|---|---|---|---|
| | Quantity. | Value. | Quantity. | Value. |
| Briquets, fuel ---- short tons | (a b) | (a b) | (a b) | (a b) |
| Clay products | | [c d] $765,644 | | [c d] $926,536 |
| Clay, raw ---- short tons | 160 | [b] 480 | 230 | [b] 748 |
| Coke ---- do | (a b) | (a b) | (a b) | (a b) |
| Iron ore: | | | | |
| Sold to furnaces ---- long tons | 117,755 | 300,954 | 794,673 | 2,455,660 |
| Sold for paint ---- do | 1,455 | 3,411 | 4,622 | 9,611 |
| Iron, pig ---- do | 93,666 | [b] 2,730,155 | 209,289 | [b] 4,970,227 |
| Lead ---- short tons | 972 | 87,480 | 691 | 76,010 |
| Lime ---- do | 124,078 | 999,407 | 189,558 | 1,589,931 |
| Manganiferous ore ---- long tons | | | 2,860 | (a) |
| Marl, calcareous ---- short tons | | | (a) | (a) |
| Mica, sheet ---- pounds | (a) | (a) | | |
| Mineral paints, zinc and lead pigments ---- short tons | (a b) | (a b) | 9,217 | [b] 1,121,235 |
| Mineral waters ---- gallons sold | 5,665,797 | 1,726,333 | 6,126,143 | 2,120,669 |
| Peat ---- short tons | (a) | (a) | | |
| Potash ($K_2O$) ---- do | (a) | (a) | | |
| Pyrites ---- long tons | (a) | (a) | 600 | 1,651 |
| Sand and gravel ---- short tons | 2,899,809 | 1,783,178 | 3,433,996 | 1,957,624 |
| Sand-lime brick ---- thousands | (a d) | (a d) | (e) | (e) |
| Silica (quartz) ---- short tons | (a) | (a) | (a) | (a) |
| Stone ---- do | [f] 1,743,770 | [f] 3,569,929 | [g] 1,800,230 | [g] 3,310,387 |
| Sulphuric acid [h] ---- do | (a d) | (a d) | (e) | (e) |
| Zinc ---- do | 3,390 | 339,000 | 10,952 | 1,248,528 |
| Miscellaneous [i] | | 6,303,364 | | 7,250,442 |
| Total value, eliminating duplications | | 9,990,961 | | 13,822,883 |

[a] Value included under "Miscellaneous."
[b] Value not included in total value for State.
[c] Exclusive of pottery, value for which is included under "Miscellaneous."
[d] Figures obtained through cooperation with Bureau of the Census.
[e] No canvass for 1922.
[f] Exclusive of basalt, value for which is included under "Miscellaneous."
[g] Exclusive of unclassified stone, value for which is included under "Miscellaneous."
[h] From zinc smelting.
[i] Includes minerals indicated by "a," "e," "f," and "g" above.

*Mineral production of Wyoming in 1921 and 1922.*

| Product. | 1921 | | 1922 | |
|---|---|---|---|---|
| | Quantity. | Value. | Quantity. | Value. |
| Clay products | | [a] $252,401 | | ([a] [b]) |
| Clay, raw short tons | 433 | [c] 2,155 | 466 | [c] $7,313 |
| Coal do | 7,200,666 | 23,358,500 | 5,971,724 | 18,162,000 |
| Copper pounds | 10,000 | 1,290 | 4,296 | 580 |
| Gems and precious stones | | ([b]) | | |
| Gold troy ounces | 3 | 62 | 58 | 1,207 |
| Gypsum short tons | 38,927 | 224,258 | 47,222 | 269,574 |
| Iron ore long tons | 234,701 | ([b]) | 332,800 | ([b]) |
| Lime short tons | ([b]) | ([b]) | ([b]) | ([b]) |
| Mineral waters gallons sold | ([b]) | ([b]) | ([b]) | ([b]) |
| Natural gas M cubic feet | 15,608,000 | 1,715,000 | 23,427,000 | 3,031,000 |
| Natural-gas gasoline gallons | 14,557,684 | 1,599,591 | 19,967,103 | 2,251,329 |
| Petroleum barrels | 19,332,800 | 23,528,000 | 26,715,000 | 33,955,000 |
| Sand and gravel short tons | 218,974 | 80,929 | 328,401 | 94,570 |
| Silver troy ounces | 111 | 111 | 57 | 57 |
| Sodium sulphate from natural sources short tons | ([b]) | ([b]) | ([b]) | ([b]) |
| Stone do | 112,340 | 239,525 | 104,390 | 205,798 |
| Miscellaneous [d] | | 365,483 | | 558,169 |
| Total value, eliminating duplications | | 51,365,150 | | 58,529,284 |

[a] Figures obtained through cooperation with Bureau of the Census.
[b] Value included under "Miscellaneous."
[c] Value not included in total value for State.
[d] Includes minerals indicated by "[b]" above.

# PREFATORY NOTE TO THE REPORTS ON GOLD, SILVER, COPPER, LEAD, AND ZINC.

By G. F. Loughlin,
*Geologist in Charge, Division of Mineral Resources.*

In the mining industry, gold, silver, copper, lead, and zinc are closely related in both the genesis and the geologic occurrence of their ores, as well as in mining and metallurgic treatment. Of their ores some contain all five metals, many contain three or four and few contain only one. Gold and silver, for instance, almost everywhere show close genetic relations, and their ores are usually mined together. Lead and zinc constitute a similar pair. Copper ores almost invariably yield some silver and gold as well as copper, and most lead ores yield notable supplies of silver. Zinc ores in the Western States contribute also to the production of silver. All five metals may occur in commercial quantity in a single mine or, more commonly, in a single mining district. For these reasons each of these metals is treated in Mineral Resources in a general report, and all five metals are grouped together in "mines reports" descriptive of individual or geographically grouped States. These reports are published in 16 pamphlets.

To facilitate advance publication each report is published separately at the earliest date possible. The general reports give figures of the output of the metals in the first marketable form, as obtained from the smelters, refineries, and mints, together with general reviews of the respective industries for the entire country. The figures given in the general reports represent the final official statistics of production for the country and of the States. The general report on gold and silver includes the statistics of recovered precious metals as determined jointly by the Bureau of the Mint and the United States Geological Survey. The "mines reports" give figures of the production (called "mine production") as obtained from the mines, so far as possible in terms of recoverable metal in ores and other material sold or treated during the year; they also supply information in detail relative to the mining industry in the respective States, counties, and mining districts.

These reports, which appear as separate chapters in this volume, are as follows:

Gold and silver (general report).
Copper (general report).
Lead (general report).
Zinc (general report).
Gold, silver, copper, lead, and zinc in the Eastern States (mines report).
Silver, copper, lead, and zinc in the Central States (mines report).
Gold, silver, copper, and lead in Alaska (mines report).
Gold, silver, copper, lead, and zinc in Arizona (mines report).
Gold, silver, copper, lead, and zinc in California and Oregon (mines report).
Gold, silver, copper, lead, and zinc in Colorado (mines report).
Gold, silver, copper, lead, and zinc in Idaho and Washington (mines report).
Gold, silver, copper, lead, and zinc in Montana (mines report).
Gold, silver, copper, lead, and zinc in Nevada (mines report).
Gold, silver, copper, lead, and zinc in New Mexico and Texas (mines report).
Gold, silver, copper, and lead in South Dakota and Wyoming (mines report).
Gold, silver, copper, lead, and zinc in Utah (mines report.)

In stating quantity of ores, concentrates, and similar material the short ton of 2,000 pounds is used throughout. The term "ore" as used here denotes any metalliferous material treated at the mine or shipped to reduction plants and paid for by those plants, whether or not it nets a profit to the miner. The ore classification is necessarily arbitrary because of the varying factors affecting mining and treatment of ores. Dry and siliceous ores comprise gold and silver ores proper, as well as fluxing ores that carry considerable quantities of iron and manganese oxides and very small quantities of gold and silver, and also gold and silver ores that carry copper, lead, or zinc in quantities too low to classify them as copper, lead, zinc, or mixed ores. The copper ores include the great disseminated copper deposits of the West, the copper ores of the Lake Superior region, and other ores in which copper is the most abundant base metal paid for. The lead and zinc ores are those in which lead or zinc is the only or chief base metal present, irrespective of their precious-metal content. The mixed ores are those whose commercial value depends on the recoverable or recovered contents of two or more base metals in addition to any precious metal they may contain. If one of the metals, though present in sufficient quantity, is not recovered, that metal is disregarded in naming the ore. An improvement in metallurgy may later serve to change the name of such ore. The classification based on methods of treatment is the only satisfactory commercial classification.

It is to be understood, of course, that market values are not received by producers for metals in ore and intermediate products, nor always for metals in marketable form, that payment is made in accordance with contracts for treatment or sale, and therefore that average daily quotations do not necessarily agree with average prices received.

Any of the reports mentioned here may be obtained, as long as the supply lasts, on request made to the Director, United States Geological Survey, Washington, D. C.

*Prices of silver, copper, lead, and zinc, 1850–1922.*

| Year. | Silver.[a] | Copper.[b] | Lead.[c] | Zinc.[d] | Year. | Silver.[a] | Copper.[b] | Lead.[c] | Zinc.[d] |
|---|---|---|---|---|---|---|---|---|---|
| | *Per fine ounce.* | *Per pound.* | *Per pound.* | *Per pound.* | | *Per fine ounce.* | *Per pound.* | *Per pound.* | *Per pound.* |
| 1850 | $1.32 | $0.22 | $0.05 | | 1887 | $0.98 | $0.138 | $0.045 | $0.046 |
| 1851 | 1.34 | .166 | .05 | | 1888 | .94 | .168 | .044 | .049 |
| 1852 | 1.33 | .22 | .05 | | 1889 | .94 | .135 | .039 | .05 |
| 1853 | 1.35 | .22 | .06 | $0.055 | 1890 | 1.05 | .156 | .045 | .055 |
| 1854 | 1.35 | .22 | .06 | | 1891 | .99 | .128 | .043 | .05 |
| 1855 | 1.34 | .27 | .07 | | 1892 | .87 | .116 | .041 | .046 |
| 1856 | 1.34 | .27 | .066 | | 1893 | .78 | .108 | .037 | .04 |
| 1857 | 1.35 | .25 | .06 | | 1894 | .63 | .095 | .033 | .035 |
| 1858 | 1.34 | .23 | .06 | | 1895 | .65 | .107 | .032 | .036 |
| 1859 | 1.36 | .22 | .055 | | 1896 | .68 | .108 | .03 | .039 |
| 1860 | 1.35 | .23 | .056 | | 1897 | .60 | .12 | .046 | .041 |
| 1861 | 1.33 | .22 | .05 | | 1898 | .59 | .124 | .038 | .046 |
| 1862 | 1.35 | .22 | .06 | | 1899 | .60 | .171 | .045 | .058 |
| 1863 | 1.345 | .34 | .06 | | 1900 | .62 | .166 | .044 | .044 |
| 1864 | 1.345 | .47 | .07 | .139 | 1901 | .60 | .167 | .043 | .041 |
| 1865 | 1.337 | .392 | .066 | | 1902 | .53 | .122 | .041 | .048 |
| 1866 | 1.339 | .342 | .07 | | 1903 | .54 | .127 | .042 | .054 |
| 1867 | 1.33 | .254 | .065 | | 1904 | .58 | .128 | .043 | .051 |
| 1868 | 1.326 | .23 | .065 | | 1905 | .61 | .156 | .047 | .059 |
| 1869 | 1.325 | .242 | .06 | | 1906 | .68 | .193 | .057 | .061 |
| 1870 | 1.328 | .212 | .06 | | 1907 | .66 | .20 | .053 | .059 |
| 1871 | 1.325 | .241 | .06 | | 1908 | .53 | .132 | .042 | .047 |
| 1872 | 1.322 | .356 | .064 | | 1909 | .52 | .13 | .043 | .054 |
| 1873 | 1.297 | .280 | .06 | | 1910 | .54 | .127 | .044 | .054 |
| 1874 | 1.278 | .220 | .06 | | 1911 | .53 | .125 | .045 | .057 |
| 1875 | 1.24 | .227 | .058 | .07 | 1912 | .615 | .165 | .045 | .069 |
| 1876 | 1.16 | .21 | .061 | .072 | 1913 | .604 | .155 | .044 | .056 |
| 1877 | 1.20 | .19 | .055 | .06 | 1914 | .553 | .133 | .039 | .051 |
| 1878 | 1.15 | .166 | .036 | .049 | 1915 | .507 | .175 | .047 | .124 |
| 1879 | 1.12 | .186 | .041 | .052 | 1916 | .658 | .246 | .069 | .134 |
| 1880 | 1.15 | .214 | .05 | .055 | 1917 | .824 | .273 | .086 | .102 |
| 1881 | 1.13 | .182 | .048 | .052 | 1918 | .98 | .247 | .071 | .091 |
| 1882 | 1.14 | .191 | .049 | .053 | 1919 | 1.12 | .186 | .053 | .073 |
| 1883 | 1.11 | .165 | .043 | .045 | 1920 | 1.09 | .184 | .08 | .081 |
| 1884 | 1.11 | .13 | .037 | .044 | 1921 | 1.00 | .129 | .045 | .05 |
| 1885 | 1.07 | .108 | .040 | .043 | 1922 | 1.00 | .135 | .055 | .057 |
| 1886 | .99 | .111 | .046 | .044 | | | | | |

[a] Report of Director of the Mint, pp. 212–213, 1914. Equivalent value of fine ounce based on average price and average rate of exchange. For 1916, 1917, and 1919, dealers' buying price, New York. For 1918, average price as stated by the Bureau of the Mint. For 1920, 1921, and 1922, New York market price for domestic silver only.

[b] Weed, W. H., Copper Handbook, vol. 11, pp. 1339, 1343, for years 1850–1903. By computation from data for years 1850–1860, p. 1339. Survey computations for electrolytic copper since 1904. For 1916 and later years, average price all marketable grades.

[c] New York price; Ingalls, W. R., Lead and zinc in the United States, p. 203, 1908. U. S. Geological Survey since 1904. For 1916, outside spot quotations, New York. For 1917 and later years, average price all grades.

[d] New York price, 1875–1904; Ingalls, W. R., Lead and zinc in the United States, p. 342, 1908. St. Louis price, U. S. Geological Survey since 1904. For 1915 and later years, average price all grades. According to C. E. Siebenthal for 1853 and 1864.

# CADMIUM.[1]

By C. E. Siebenthal and A. Stoll.

## THE CADMIUM INDUSTRY.

The production of cadmium in the United States began in a small way in 1906 and grew steadily until 1917, when the maximum output was reached. It has decreased materially since 1917.

The production of metallic cadmium in 1922 was nearly double the production in 1921. The increase in sales amounted to 96 per cent. As in several preceding years, the sales exceeded the production, so that stocks were further reduced. The average price of cadmium gained 11 cents a pound.

The output of cadmium sulphide was more than double that of 1921, and the sales, though less than the production, showed a big gain over those of the previous year. The average price of cadmium sulphide gained 4 cents a pound.

Cadmium was also marketed in the form of cadmium oxide and cadmium hydrate for use in the udylite process of cadmium electroplating.

The udylite process, covered by United States patents 1383174, 1383175, and 1383176, with other patents pending, embodies electroplating with cadmium and subsequent heating in an oven for several hours at 150°–200° C., by which the cadmium coating is alloyed with the metal of the article coated. This process has been applied to rust-proofing locks, hardware, kitchen-cabinet and refrigerator trimmings, automobile parts and accessories, and such wire products as screen wire, wire ropes, and fence wire. The plating solution employed is sodium cyanide saturated with cadmium. Metallic cadmium anodes are mentioned in the patents, but in practice graphite or steel anodes are used. The advantages claimed for the electrodeposited and baked cadmium coat are thinness; freedom from peeling; more effective rust protection owing to the alloy formed; adaptability to various finishes from bright to soft satin and French gray; adaptability to further electroplating, as with nickel, copper, or brass. In 1921 the udylite process was installed at 18 plants, and by the end of 1922 more than 50 plants were in operation and new installations were proceeding at the rate of 6 or 8 a month. The

[1] A more complete account of the production, resources, metallurgy, and uses of cadmium was given in Mineral Resources for 1908. Another account describing in some detail the cadmium-bearing by-products produced in the United States and their possibilities as commercial sources of cadmium and giving the results of attempts to substitute cadmium for tin in solders was included in Mineral Resources for 1918. A bibliography of the principal articles and books on cadmium that have appeared in recent years is given in the chapter on cadmium in Mineral Resources for 1921. A statement of the commercial standards of quality, with typical analyses, is also given in that chapter.

consumption of cadmium oxide in this process at the end of 1922 was at the rate of about 1,500 pounds a month. A discussion of the merits of cadmium electroplating will be found in the Monthly Review of the American Electroplaters' Society for June and July, 1922, and in The Metal Industry for September and December, 1922.

## PRODUCTION.

There are several cadmium minerals, but none of them occur in quantities large enough to be called ores. The cadmium of commerce is derived from zinc minerals and ores, in practically all of which it occurs in minute quantity, the ratio being about 1 of cadmium to 200 of zinc. Cadmium behaves metallurgically almost the same as zinc and hence constitutes a fraction of 1 per cent of almost all metallic zinc. The sources of cadmium that have been utilized are zinc ores treated by fractional distillation, lead-furnace baghouse "fumes" (the cadmium content of which is derived from the zinc minerals contained in the charge of lead ore), and residues from the purification vats of electrolytic zinc plants and lithopone plants. The production of cadmium, either as metal or in compounds, was reported by the companies in the following list, which shows also the nature of the metallurgic plant in connection with which the cadmium is recovered:

*Producers of cadmium in the United States in 1920–1923.*

| Company. | Location of plant. | Associated plant. |
|---|---|---|
| American Smelting & Refining Co | Denver, Colo. | Lead smelter. |
| Anaconda Copper Mining Co. | Great Falls, Mont. | Electrolytic zinc plant. |
| Grasselli Chemical Co. | Cleveland, Ohio. | Chemical works. |
| Krebs Pigment & Chemical Co. | Newport, Del. | Lithopone plant. |
| Midland Chemical Co. | Argo, Ill. | Do. |
| Mineral Refining & Chemical Corporation | Carondelet, Mo. | Do. |
| New Jersey Zinc Co. | Palmerton, Pa. | Do. |
| United States Smelting, Refining & Mining Co. | Kennett, Calif. | Electrolytic zinc plant. |
| Do. | Midvale, Utah. | Lead smelter. |

Several years ago the Anaconda Copper Mining Co. worked out experimentally a method to recover the cadmium precipitated in purifying the zinc solution for electrolysis at the Great Falls plant. That company began the production of metallic cadmium in a commercial way early in 1923 and promises to become one of the largest producers.

The following table, compiled from reports by each producer of cadmium in the United States and from official reports of the Upper Silesian output, shows that from 1910 until 1918 the production of cadmium in the United States gained rapidly on that of Upper Silesia and at length surpassed it, but in 1918 Upper Silesia reached her maximum output, with nearly twice the reduced production of the United States in that year. The production of these two countries has constituted practically the whole cadmium output of the world, though a small quantity is made at electrolytic zinc plants in England, and in 1922 Belgium and Tasmania were reported to be exporting cadmium to England.

*Metallic cadmium and cadmium sulphide produced in the United States and Upper Silesia, 1906–1922.*

| Year. | United States. | | | | | | Upper Silesia (metallic cadmium). | | |
|---|---|---|---|---|---|---|---|---|---|
| | Metallic cadmium. | | | Cadmium sulphide. | | | | | |
| | Pounds. | Value. | | Pounds. | Value. | | Pounds. | Value. | |
| | | Total. | Average. | | Total. | Average. | | Total. | Average. |
| 1906 | 300 | $300 | $1.00 | (a) | | | 47,368 | $36,083 | $0.76 M. 3.19 |
| 1907 | 14,000 | 14,350 | 1.025 | (a) | | | 72,639 | 60,757 | .84 3.54 |
| 1908 | 8,000 | 6,000 | .75 | (a) | | | 72,741 | 48,590 | .67 2.81 |
| 1909 | 5,300 | 2,783 | .525 | (a) | | | 81,982 | 46,777 | .57 2.39 |
| 1910 | 4,700 | 2,585 | .55 | (a) | | | 90,516 | 39,309 | .43 1.81 |
| 1911 | 26,152 | 17,566 | .67 | 2,392 | $1,674 | $0.70 | 93,861 | 53,372 | .57 2.39 |
| 1912 | 52,508 | 39,875 | .76 | 8,998 | 6,400 | .71 | 94,262 | 63,507 | .67 2.81 |
| 1913 | 54,198 | 41,838 | .77 | 17,302 | 12,136 | .70 | 81,993 | 63,641 | .78 3.27 |
| 1914 | [b] 91,409 | 81,205 | .89 | 22,723 | 20,241 | .89 | [c] 86,362 | | [c] 2.95 |
| 1915 | 91,415 | 108,443 | 1.19 | 10,624 | 12,057 | 1.13 | [c] 82,177 | | [c] 2.90 |
| 1916 | 135,212 | 210,931 | 1.56 | 22,176 | 27,942 | 1.26 | [c] 127,341 | | [c] 4.81 |
| 1917 | 207,408 | 305,097 | 1.47 | 50,169 | 70,939 | 1.41 | [c] 172,284 | | [c] 6.73 |
| 1918 | 127,164 | 188,203 | 1.48 | 51,702 | 70,315 | 1.36 | [c] 235,512 | | [c] 6.32 |
| 1919 | 99,939 | 121,926 | 1.22 | 31,197 | 37,436 | 1.20 | [c] 85,395 | | [c] 16.51 |
| 1920 | 129,283 | 151,261 | 1.17 | 32,133 | 37,274 | 1.16 | [c] 45,971 | | [c] 45.27 |
| 1921 | [d] 68,501 | [d] 67,131 | .98 | 65,446 | 71,336 | 1.09 | [e] 47,487 | | |
| 1922 | [b] 131,590 | 143,433 | 1.09 | 134,774 | 152,295 | 1.13 | (f) | | |
| | 1,247,079 | 1,502,927 | | 449,636 | 520,045 | | | | |

[a] No production.
[b] Exclusive of cadmium in residues sold for export.
[c] Statistics of production and average selling price for 1914–1919 from Gluckauf, vol. 56, pp. 818–819; for 1920, vol. 57, p. 367, 1921. The value is expressed in marks only, because the exchange value of the mark is not available for part of the period.
[d] Revised figures.
[e] Consular report, Aug. 25, 1922.
[f] Statistics not available.

Neither the quantity nor the value of cadmium marketed in the form of oxide and hydrate may be revealed without disclosing individual output.

## CADMIUM LITHOPONE.

The production of the pigment cadmium lithopone seems to have made no particular progress during the year, as only experimental quantities were reported to the Survey. John R. Marston was granted United States patent No. 1399506, December 6, 1921, for a process of making a cadmium-zinc-barium pigment that is essentially a cadmium-zinc lithopone. By this process zinc-dust precipitates from zinc sulphate solution obtained in the hydrometallurgical treatment of complex ores are treated with sulphuric acid at such a temperature that the zinc and cadmium will dissolve but not the other metals. After filtration the zinc-cadmium solution is treated with a suitable sulphide, such as barium sulphide, and the precipitate is washed, dried, and ground, yielding a pigment of deep-yellow to orange color.

## CADMIUM-VAPOR ARC LAMP.

In physical investigations there is often need for monochromatic lights of different colors. The quartz mercury-vapor lamp, for instance, furnishes one such light, a yellow-green. A source of intense monochromatic red light has recently been developed by the

Bureau of Standards in the new quartz cadmium-vapor lamp.[2] In this lamp the cadmium is alloyed with a very small fraction of 1 per cent of gallium, giving a lamp of long life and very free from clouding by adhesion of the cadmium vapor to the walls of the lamp.

## IMPORTS AND EXPORTS.

The following table, which is taken from the records of the Bureau of Foreign and Domestic Commerce, shows the imports of metallic cadmium only, as the quantity and value of cadmium imported as pigment are not recorded separately.

*Cadmium imported and entered for consumption in the United States, 1910–1922.*

| Year. | Pounds. | Value. | Year. | Pounds. | Value. |
|---|---|---|---|---|---|
| 1910 | 4,060 | $2,295 | 1914 | 441 | $368 |
| 1911 | 5,367 | 3,870 | 1915 | 269 | 284 |
| 1912 | 5,250 | 3,764 | 1916–1920 | ..... | ..... |
| 1913 | 1,656 | 1,232 | 1921 | 101 | 216 |
| | | | 1922 | 2,240 | 2,434 |

It is reported that offerings of cadmium from the electrolytic zinc plant at Risdon, Tasmania, near the end of the year threatened to demoralize the cadmium market of the United States.

Statistics of the exports of cadmium are not separately kept by the Bureau of Foreign and Domestic Commerce, but it is known that a considerable quantity of domestic stick cadmium was exported during the World War and some at other times. Such figures of exports as are available are given in the chapter on cadmium in Mineral Resources for 1919. Cadmium-bearing residues are also known to have been exported at times. In 1922 considerable quantities of cadmium-bearing residues were shipped to Europe for treatment during a period of cadmium scarcity. Extensive electrification of State railways in Europe may call for further exports of cadmium from the United States for use in the transmission wires.

Cadmium is imported into the United States as metallic stick cadmium and as the pigment cadmium sulphide. Under the tariff act of August 5, 1909, metallic cadmium was admitted free of duty, and cadmium sulphide was dutiable at 30 per cent ad valorem. Under the tariff act of October 3, 1913, metallic cadmium was admitted free of duty and cadmium sulphide was dutiable at 15 per cent ad valorem. The tariff act of 1922 imposes a specific duty of 15 cents a pound on metallic cadmium and an ad valorem duty of 40 per cent on cadmium sulphide.

## PRICES AND VALUE.

The price of metallic cadmium was quoted at $1.10 to $1.25 a pound at the beginning of 1922 and showed no change until the middle of June, when it rose to $1.20 to $1.25 a pound. During the last quarter of the year the price was stationary at $1.15 a pound.

[2] Bates, Frederick, The new cadmium-vapor arc lamp: Bur. Standards Sci. Paper 371, pp. 43–50, 1920.

Cadmium sales are so irregular, however, that the quotation is nominal much of the time, and sales in large lots are made at figures considerably less than the quoted price. The average price of metallic cadmium for 1922, based on sales reported by producers, was $1.09 a pound, as compared with $0.98 in 1921. The average price of cadmium sulphide in 1922 was $1.13 a pound, compared with $1.09 in 1921. The average price of cadmium oxide and of cadmium hydrate may not be disclosed.

The value of the metallic cadmium produced in the United States in 1922, at the average price stated above, was $143,433, as compared with $67,131 in 1921. The value of the cadmium sulphide produced in 1922 amounted to $152,295, as compared with $71,336 in 1921.

# GOLD, SILVER, COPPER, LEAD, AND ZINC IN THE EASTERN STATES.[1]

By J. P. Dunlop.

## MINE PRODUCTION.

The total value of the gold, silver, copper, lead, and zinc mined and sold in the Eastern States in 1922 showed an increase of about 26 per cent from the corresponding value in 1921. Of the total value gold represented $12,821; silver, $80,935; copper, $2,089,327; lead, $80,960; and zinc, $13,616,990. The increase was caused mainly by the increased output and price of lead and zinc and the slightly higher selling price of copper.

*Mine production of gold, silver, copper, lead, and zinc in the Eastern States, 1921–22.*

| Year. | Number of mines. | Ore sold or treated. | Gold. | Silver. | Copper. | Lead. | Zinc. | Total value. |
|---|---|---|---|---|---|---|---|---|
| | | *Short tons.* | | *Fine oz.* | *Pounds.* | *Pounds.* | *Pounds.* | |
| 1921 | 27 | 1,502,277 | $9,934 | 98,792 | 15,397,596 | ..... | 135,422,000 | $12,616,046 |
| 1922 | 29 | 2,274,175 | 12,821 | 80,935 | 15,476,497 | 1,472,000 | 188,082,000 | 15,881,033 |
| Increase or decrease, 1922 | +2 | +771,898 | +2,887 | −17,857 | +78,901 | +1,472,000 | +52,660,000 | +3,264,987 |

### GOLD.

Of the mine output of gold in 1922 placers yielded $2,290, siliceous gold ores $3,111, and copper and copper-lead ores $7,420. The deep and placer gold mines, which in former years produced nearly all the gold in the Eastern States, supplied only 42 per cent in 1922, and the character of the operations at such mines is best shown by the fact that their total output of $5,401 was derived from 19 properties. The small quantity of siliceous ore mined was treated in small mills by amalgamation, and none of the large mills or cyanide plants were operated. Most of the ore is of low grade, and the continued high cost of supplies and the scarcity of available labor prevented profitable mining. The gold obtained in refining copper bullion is the only uninterrupted source of gold in these States in the last four years. The value of the estimated gold production of the southern Appalachian States for the period 1799–1921 is $51,045,732.[2]

[1] U. S. Geol. Survey Mineral Resources, 1908, pt. 1, pp. 645–681, contains references to the geology of the several States and gives a list of the Geological Survey, State survey, and other publications relating to the geology and mines in all the Eastern States; and U. S. Geol. Survey Mineral Resources, 1914, pt. 1, pp. 139–163, contains a historical review of the production of gold in the southern Appalachian States and a list of Survey publications on gold, silver, copper, lead, and zinc in the Eastern States.

[2] Director of the Mint Ann. Rept., 1922, p. 39.

## SILVER.

More than 99 per cent of the output of silver in 1922 was derived from copper ores and copper-lead ores, and all the remainder except 8 ounces came from siliceous ores.

*Mine production of gold and silver in the Eastern States in 1922, by States.*

| State. | Gold. | | Silver. | | Increase or decrease in value compared with 1921. | |
|---|---|---|---|---|---|---|
| | Fine ounces. | Value. | Fine ounces. | Value. | Gold. | Silver. |
| Georgia | 155.96 | $3,224 | 364 | $364 | +$2,202 | +$360 |
| North Carolina and South Carolina | 95.35 | 1,971 | 9 | 9 | −1,258 | −9 |
| Pennsylvania | 125.78 | 2,600 | 2,215 | 2,215 | +2,600 | +2,215 |
| Tennessee | 208.98 | 4,320 | 78,341 | 78,341 | −600 | −20,421 |
| Virginia | 34.15 | 706 | 6 | 6 | −57 | −2 |
| | 620.22 | 12,821 | 80,935 | 80,935 | +2,887 | −17,857 |
| Total, 1921 | 480.55 | 9,934 | 98,792 | 98,792 | ..... | ..... |

*Mine production of gold and silver in the Eastern States in 1922, by sources, in fine ounces.*

| State. | Gold. | | | | Silver. | | | |
|---|---|---|---|---|---|---|---|---|
| | Placers. | Dry or siliceous ores. | Copper ores. | Lead and copper-lead ores. | Placers. | Dry or siliceous ores. | Copper ores. | Lead and copper-lead ores. |
| Georgia | 83.35 | 48.42 | ..... | 24.19 | 6 | 8 | ..... | 350 |
| North Carolina | 25.88 | 67.92 | ..... | ..... | 2 | 7 | ..... | ..... |
| Pennsylvania | ..... | ..... | 125.78 | ..... | ..... | ..... | 2,215 | ..... |
| South Carolina | 1.55 | ..... | ..... | ..... | ..... | ..... | ..... | ..... |
| Tennessee | ..... | ..... | 208.98 | ..... | ..... | ..... | 78,341 | ..... |
| Virginia | ..... | 34.15 | ..... | ..... | ..... | 6 | ..... | ..... |
| | 110.78 | 150.49 | 334.76 | 24.19 | 8 | 21 | 80,556 | 350 |
| Total, 1921 | 76.97 | 165.58 | 238.00 | ..... | 7 | 23 | 98,762 | ..... |

## COPPER.

The mine production of copper in the Eastern States in 1922 was valued at $2,089,327, an increase of $103,037. Of the total output 14,240,571 pounds was derived from Tennessee copper ores and 1,229,926 pounds from Pennsylvania pyritiferous magnetite ore.

The total quantity of ore treated to produce this copper was 1,281,326 short tons. Exclusive of the magnetite ore, which was mined for its iron content and contained very little copper, the average yield of copper from copper ores was approximately 1.28 per cent, or 25.5 pounds to the ton, and this copper ore also yielded $0.15 in gold and silver to the ton. Copper ores directly smelted amounted to 419,310 tons, from which about 11,436,577 pounds of copper was recovered. Copper and pyritiferous magnetite ores concentrated amounted to 862,016 tons, which yielded 27,103 tons of concentrates containing 4,033,920 pounds of copper and small quantities of gold and silver. Some copper-lead ore was mined and concentrated in Georgia that also yielded gold and silver.

### LEAD.

Shipments of lead and copper-lead ores were reported by mines in Georgia and Tennessee in 1922. No shipments were reported in 1921.

### ZINC.

The recoverable zinc in the ore mined in the Eastern States in 1922 was valued at $13,616,990, an increase of $3,095,960. New Jersey produced 147,314,000 pounds, Tennessee 31,136,000 pounds, and New York 9,632,000 pounds. Zinc ore mined and treated amounted to 989,901 tons, of which 512,290 tons was from New Jersey and 53,400 tons from New York. Nearly all the zinc ore from Tennessee and New York was sent to concentrating plants, and 450,187 tons of the zinc ore from New Jersey was concentrated and the remainder shipped as crude ore.

## REVIEW BY STATES.

### ALABAMA.

The value of the gold produced by mines in Alabama during the period 1830 to 1921 was $766,632.[3]

No production of gold or silver was reported from mines in Alabama in 1922. Old properties, such as the Gold Log, Gold Ridge, and other mines in Cherokee, Randolph, and Tallapoosa counties, were idle. Only prospect work was done at the Jemison property, in Chilton County.

### GEORGIA.

The value of the gold produced in Georgia during the period 1830 to 1921 was $17,826,290,[3] or more than one-third of the estimated total production of the southern Appalachian States.

In 1922 mines in Georgia produced 155.96 ounces of gold, valued at $3,224, and 364 ounces of silver, an increase of $2,202 in the value of gold and an increase of 360 ounces in the quantity of silver, as compared with 1921. Small quantities of gold and silver were reported from prospect work, and a little siliceous ore was milled. Most of the gold was derived by hydraulicking or sluicing gravels, and operations were spasmodic and small, though more extensive than in 1921.

Placer production was reported from Cherokee, Lumpkin, and White counties. A little of the placer gold from Cherokee County was derived from small creeks 4 miles north of Canton, but the largest output of placer gold came from the old Creighton mine near Ball Ground. The Gold Hill placer, near Nocoochee, in White County, was worked by hydraulic mining for 30 days. The producing placers at Dahlonega were the Lockhart and Barton hydraulic mines, which were worked intermittently. Some of the nuggets recovered were kept as specimens.

The deep mines in Georgia yielded $1,501 in gold and 358 ounces of silver in 1922. Most of this output was derived from copper-lead concentrates shipped from the old Magruder mine, in Lincoln County, operated by the Georgia Copper Co. Other deep mines

[3] Director of the Mint Ann. Rept., 1922, p. 39.

producing gold and silver were the Childs mine, in White County; the Haughey mine, near Rayle, in Wilkes County; the Smith mine, of the Rabun Mining & Development Co., near Tiger, in Rabun County; and the Findley mine, at Dahlonega, in Lumpkin County, which was operated by lessees of the Water Power & Mining Co. The Crown Mountain mine was taken over by Kimber, Warfield, Ahlman & Co., who are installing a hydraulic plant. Development work was continued on the Turkey Hill mine by Dr. Craig R. Arnold. At the Columbia mine, in McDuffie County, no ore was mined, and the small quantity of gold recovered was a clean-up from former operations.

The Magruder mine shaft is 285 feet deep. Oil flotation is used to recover the concentrates from the crude ore. The concentrates were shipped to the American Smelting & Refining Co.'s plant at Perth Amboy, N. J., in 1922. The mine and mill developments have been extensive, and it is proposed to add a smelter and sulphuric acid plant to the equipment.

### MAINE, MARYLAND, NEW HAMPSHIRE, AND VERMONT.

Apparently none of the gold or copper mines in Maine, Maryland, New Hampshire, or Vermont were operated in 1922. The estimated total gold production from Maryland has been $71,405, none of which has been produced during the last 10 years.

### MASSACHUSETTS.

The old Chipman mine, at Highfield, Essex County, Mass., which was reopened in 1919 by the Merrimac Development Co., was closed in February, 1921, and was sold in October, 1922, by court order, for $1,500. It was not unwatered, nor was any ore shipped, though efforts were being made to induce old stockholders to invest in a new corporation to reopen the mine. A brief but comprehensive description of the workings of the mine and the character of the ore, by G. F. Loughlin, is contained in the chapter on gold, silver, copper, lead, and zinc in the Eastern States in 1919, copies of which may be obtained upon application to the Director, United States Geological Survey, Washington, D. C. Some records of operations, 1872–1921, are given in an article by Frederick E. Green.[4]

### NEW JERSEY.

The production of zinc ore in New Jersey in 1922 was, as usual, confined to the Mine Hill and Sterling mines, at Franklin Furnace, Sussex County, and amounted to 512,290 tons, which contained 147,314,000 pounds of recoverable zinc. The crude ore produced in 1921 amounted to 400,080 tons and contained 112,894,000 pounds of recoverable zinc. Only a part of the zinc ore mined at Franklin Furnace is used directly for the manufacture of zinc. The greater part of this zinc is normally converted into oxide at works in Pennsylvania.

[4] Vicissitudes of silver mining at Newburyport, Mass.: Eng. and Min. Jour.-Press, Mar. 17, 1923, p. 483.

## NEW YORK.

The quantity of zinc ore from New York treated in 1922 was 53,400 tons. The concentrates shipped in 1922, which included some concentrates derived from ore treated in 1921, contained 9,632,000 pounds of zinc. The Northern Ore Co., operating the Brown mine, near Edwards, St. Lawrence County, treated most of this ore. A vertical shaft 1,060 feet deep was operated in 1921. None of the pyrite concentrates were sold in 1922. Ore extracted from levels at 800 to 900 feet is dropped to the 900-foot level, hoisted, and trammed by means of a gasoline motor to the mill. The mill, which is constructed of steel and tile, is equipped with crusher, rolls, Dorr thickener, and 17 tables and has a daily capacity of 250 tons. The table concentrates, which assay about 32 to 33 per cent of zinc, are treated by 13 Electric Ore Separating Co. machines, which, by removing much of the pyrite, raise the zinc content to 47 to 48 per cent. These electric machines treat wet concentrates, and to avoid the clogging of the riffles in the separator and insure their proper operation it is necessary to remove by means of a powerful magnet all the small particles of metallic iron abraded from the rolls and crusher. The average zinc assay of the crude ore treated ranges from 13 to 20 per cent, and the finished concentrates average about 47 to 48 per cent. A plant for the treatment of tailings was finished in 1922, and several new ore bodies were located by diamond drilling. It is probable that others will be discovered and mined on the large tract owned by the Northern Ore Co.

The Hyatt Ore Corporation's mine at Hyatt, 3 miles west of Edwards, had a 320-foot inclined shaft on ore very similar to that of the Northern Ore Co. The property was operated until July, 1922, when the lease expired, and the 100-ton mill was dismantled.

## NORTH CAROLINA.

The value of the gold produced in North Carolina during the period 1799 to 1921 was $23,632,759.[5] In 1915 the output of gold amounted to $172,001, but since then increased costs of mining and milling the low-grade ores and gravels have made operation so unprofitable that mining has been almost discontinued. Part of the small output of $1,939 in 1922 came from placer mines, and most of the gold from deep mines was derived from the Coggins mine, near Eldorado, in Montgomery County. None of the deep mines in Moore, Catawba, Davidson, and Rowan counties had any output. A tunnel was driven 25 feet at the Nibelung mine, in Caldwell County, and a small quantity of gold was recovered. At the Pee Dee mine, near Asheboro, in Randolph County, very little work was done and the output was small compared with its production in 1921. The Iola mine, in Montgomery County, was not operated, but some dump ore used to demonstrate a new amalgamator yielded a small quantity of gold. The only operation at the old Silver Hill mine, in Davidson County, was a small amount of core drilling. The Conrad Hill mine, near Lexington, Davidson County, was leased to the Conrad Hill Syndicate. The mine was unwatered, the shaft retimbered, and equipment installed for active operation. At the Gardner Hill property,

[5] Director of the Mint Ann. Rept., 1922, p. 39.

in Guilford County, now owned by the Greensboro Mining Co., a small concentrating plant was built which is designed to treat pyrite ore containing copper, gold, and silver. The Sylvania Mining Co. did a little development work near Rutherfordton but treated no ore. The Redding mine, near Cedar Falls, Randolph County, was leased to W. N. Brown, who did some surface trenching. The old Durgy and other mines in Person County were acquired by the United Copper Mines Co., which seeks to interest capital to install a 250-ton flotation plant to treat the copper ore. Other prospective operators in 1923 are the Rodrain Electro Metallurgical Co., at the old Gold Hill mine, Rowan County, and the Waxhaw Mining Co., the new owner of the Howie mine, in Union County, which has been idle for several years.

The placer gold produced in 1922 came from the Mountain Creek mine, in Catawba County; the Third Creek mine, near Cleveland, Rowan County; the Huntsville mine, near Marion, in McDowell County; and the slimes and sands around Gold Hill, in Rowan County.

## PENNSYLVANIA.

The Cornwall iron mines, in Lebanon County, Pa., operated steadily in 1922 by the Bethlehem Steel Co., produced several thousand tons of a low-grade copper concentrate from pyritiferous magnetite ore. The ore is taken from an open pit, and the copper and sulphur are recovered on Wilfley tables. The concentrate, which was shipped to smelters, contained about 32 per cent of sulphur and about 4 per cent of copper.

## SOUTH CAROLINA.

Mines in South Carolina produced $5,181,892 in gold during the period 1829 to 1921.[6]

The entire output of $32 in gold in 1922 consisted of nuggets picked up on creeks and gullies in Spartanburg County.

No copper ore was shipped from the mines near Smyrna, in York County, but part of the holdings of the Darenella Mining Co. were leased to Blackshear & Evans, who did prospect work. The hillside soil will be sluiced, and, if possible, the low-grade quartz ore will be sold as a flux. Some work was also being done on a prospect near Smyrna by B. S. Bonebrake, who hoisted some ore from a shaft 60 feet deep. Some development work was also done at the Smith mine, near Smyrna, which has three shafts in ore.

## TENNESSEE.

The gold produced at mines in Tennessee during the period 1831 to 1921 amounted to $269,422.[6] A large part of the output prior to 1879 was derived from placer mines, but the output since 1906 has been recovered entirely from copper ore mined in Polk County.

[6] Director of the Mint Ann. Rept., 1922, p. 39.

*Mine production of gold, silver, copper, lead, and zinc in Tennessee, 1905–1922.*

| Year. | Ore sold or treated. | Gold. | Silver. | Copper. | Lead. | Zinc. | Total value. |
|---|---|---|---|---|---|---|---|
| | *Short tons.* | | *Fine ounces.* | *Pounds.* | *Pounds.* | *Pounds.* | |
| 1905–1914 | 6,401,574 | $57,630 | 808,443 | 182,379,746 | ..... | 42,662,808 | $30,483,771 |
| 1915 | 1,149,364 | 6,862 | 100,543 | 18,046,010 | 1,660 | 32,922,902 | 7,298,406 |
| 1916 | 1,184,821 | 5,739 | 94,701 | 14,679,794 | 32,960 | 52,855,480 | 10,764,189 |
| 1917 | 1,533,983 | 5,326 | 99,053 | 16,033,749 | 5,061,937 | 56,995,107 | 10,712,985 |
| 1918 | 1,159,971 | 4,866 | 93,620 | 14,799,680 | 3,410,400 | 42,141,311 | 7,831,005 |
| 1919 | 1,227,534 | 5,662 | 98,288 | 15,623,589 | 4,376,000 | 46,494,000 | 6,647,723 |
| 1920 | 1,120,995 | 5,830 | 110,719 | 16,727,803 | 3,957,000 | 38,434,000 | 6,634,144 |
| 1921 | 889,122 | 4,920 | 98,762 | 15,084,294 | ..... | 19,384,000 | 3,018,756 |
| 1922 | 983,844 | 4,320 | 78,341 | 14,240,571 | 1,464,000 | 31,136,000 | 3,860,410 |
| | 15,651,208 | 101,155 | 1,582,470 | 307,615,236 | 18,303,957 | 363,025,608 | 87,251,389 |
| Increase or decrease, 1922 | +94,722 | −600 | −20,421 | −843,723 | +1,464,000 | +11,752,000 | +841,654 |

*Polk County.*—The entire output of copper, gold, and silver in Tennessee came from the two large copper mines in the Ducktown district, and the production of all three metals was less in 1922 than in 1921. There was a large increase in the production of both lead and zinc. The Tennessee Copper Co. operated its 2,000-ton smelter, converter, and sulphuric acid plant on crude sulphide ores from the Burra Burra and London mines. The pig copper was shipped to the Baltimore Copper Smelting & Refining Co. for refining.

The Ducktown Sulphur, Copper & Iron Co. operated its two 600-ton blast furnaces and 20-foot converter on self-fluxing sulphide ore and concentrates from the Mary and East Tennessee mines, at Isabella. Part of the crude ore was concentrated at the 400-ton flotation plant. The Mary and Isabella mines are opened by 1,200-foot vertical shafts, and the East Tennessee mine by a 700-foot shaft.

Most of the zinc produced was obtained from the Embree mine, in Washington County, and the Mascot mine, in Jefferson County, as the mines of the Union Zinc Co., in Union County, of the Tennessee Zinc Co., in Claiborne County, and of the Grasselli Zinc Co., in Jefferson County, were idle.

The Embree Iron Co. operated the Embree mine, which produces zinc carbonate and lead carbonate ores. Part of the zinc ore is shipped directly from the mines and part is concentrated by means of log washers and tables. The dried crude zinc ore and concentrates contained 41.66 per cent of zinc. Some galena ore was concentrated by means of jigs and tables into a product averaging about 55 per cent of lead.

The American Zinc Co. of Tennessee continued its steady operation of the Mascot mine. The sulphide ore was hoisted from the mine through the 800-foot shaft. The concentrating plant is equipped with jigs, tables, and oil flotation and has a capacity of 100 tons an hour. Some of the concentrates shipped from the Mascot and Embree mines in 1922 were obtained from ore mined and milled in 1921.

## VIRGINIA.

The mines of the Bertha Mineral Co., at Austinville, and the Helen Mineral Co., at Ivanhoe, in Wythe County, Va., were idle in 1922, and no recoveries of gold and silver were reported from the smelting of pyritic ores. The value of gold produced from mines in Virginia during the period 1828 to 1921 was $3,297,332,[7] of which less than $9,000 was recovered from 1911 to 1921. The deep and placer gold mines in Albemarle, Floyd, Fauquier, Goochland, and Fluvanna counties yielded about half of the total in that period; the remainder of the gold was derived from cinders of pyritic ores or copper ores shipped to smelting plants.

For the second time in recent years siliceous quartz ore was mined in Virginia, and $706 in gold and 6 ounces of silver were recovered from mines and prospects in Louisa and Orange counties. A small experimental amalgamation plant was operated on ore taken from open cuts on the R. E. Dolan property, near Mineral, Louisa County.

[7] Director of the Mint Ann. Rept., 1922, p. 39.

# BISMUTH.

By V. C. Heikes.

## PRODUCTION.

Bismuth was produced in 1922 by three firms operating plants for refining lead and tin bullion in the United States, but only one producer was willing to have his output published. About 300,000 pounds of bismuth was recovered at refining plants each of the last two years, and half of it is considered foreign product. Bolivia is the chief source of bismuth from tin ores refined in the United States. With the exception of the Llallagua tin ores and other tin ores reduced in the United States, nearly all Bolivian and Australian bismuth ores are shipped to England and reduced there. Small quantities of ore are treated in Bolivia, and the metallic bismuth in the form of ingots is exported from Quechisla for final treatment and separation of its contained metals, especially gold, silver, and copper. Mexican lead bullion and considerable lead bullion from the Western States contain a small percentage of bismuth.

According to reports received from consumers, the quantity of bismuth purchased in 1922 amounted to 226,385 pounds, including some imported metal, and cost the consumer an average of $2.26 a pound. Bismuth is consumed in largest quantities around New York, Philadelphia, and St. Louis, where the principal works making medicinal bismuth chemicals are situated. London and New York, in the order named, are the chief market centers. The New York market supplies domestic consumers with the bismuth they require.

## IMPORTS.

*Bismuth imported for consumption in the United States, 1916–1922.*

| Year. | Pounds. | Value. | Year. | Pounds. | Value. |
|---|---|---|---|---|---|
| 1916 | 76,723 | $195,975 | 1920 | 72,771 | $161,877 |
| 1917 | 69,250 | 142,300 | 1921 | 94,085 | 114,891 |
| 1918 | 135,700 | 277,273 | 1922[a] | 121,505 | 239,777 |
| 1919 | 57,607 | 55,179 | | | |

[a] Also 9,392 pounds of "compounds, mixtures, and salts of bismuth," valued at $8,681, imported September 22 to December 31, 1922. Not separately classified prior to new tariff.

## SOURCES.

Bismuth is produced in the United States principally by the lead and tin refiners, who treat domestic as well as some foreign bullion. The slime from the refining of tin at the Mellanear works in Brooklyn, N. Y., also at Perth Amboy, N. J., and from the Anaconda

electrolytic lead works in East Chicago, Ind., goes to refiners of bismuth at Omaha, Nebr., and to the plant of the U. S. S. Lead Refinery (Inc.), at East Chicago. At these works bismuth metal is recovered in the slimes as a by-product of electrolytic lead refining by the Betts process. The metal is refined electrolytically in a chloride solution carrying an excess of hydrochloric acid, at a current density of 15 to 30 amperes per square foot. The anodes are argentiferous and auriferous bismuth, and the cathodes are sheet lead; the process takes place in porcelain tanks. According to Hess,[1] so far as known, refiners of blister copper have not saved bismuth from slimes on a commercial scale, though experimentally a little has been obtained in this way.

Generally 3 per cent of bismuth is required in an ore or concentrate containing other metals before payment is considered by smelters in the western United States. Many different ores and concentrates sold to the smelter contain a little bismuth, which is usually not determined by the producer or buyer as a constituent of the ore, but if the quantity is known it is sometimes penalized. Sometimes it has enabled the producer to obtain better rates for treatment. Occasionally pockets of ore containing considerable bismuth are encountered and sold separately from other ores. In Utah some of the mines of the Tintic, Little Cottonwood, and Clifton districts have produced rich bismuth ores, and in the San Francisco and Granite districts, Beaver County, bismuthinite with other ores has been observed and mined. In the Hilltop district, near Battle Mountain, Nev., and the Eureka, Luning, and Pioche regions, in the same State, small deposits of 3 per cent ore have been opened, showing a predominance of bismite, some of which has found a market. Lead ore from Leadville, Colo., containing over 10 per cent of bismuth as carbonate, was sold to lead smelters in 1916. The Royal Tiger Mines Co., in the Breckenridge district, Colo., reports 10 per cent of bismuth in iron concentrate containing a little lead and zinc. Bismuth carbonate also occurs east of Engle, N. Mex., where the mineral is associated with copper carbonate and scheelite. Lead ore with bismuth carbonate, mined in the northern part of the Silver district, Yuma County, Ariz., was shipped in 1920 to a California smelter. This deposit is worthy of investigation.

Four minerals of bismuth are of common occurrence—native bismuth, usually in irregular masses; bismuthinite (bismuth sulphide), occurring in fine hairlike crystals, in fibrous masses, or in masses showing more or less crystal form and having a well-developed cleavage, steel-gray in color, with a high metallic luster; bismite, the oxide of bismuth; and bismutite, the basic carbonate. Both bismite and bismutite occur as gray, green, or yellowish nodules derived from the oxidization of the native metal or the sulphide. Bismite that is formed from bismuthinite usually exhibits a fibrous structure.

A simple confirmatory field test is to dissolve a fragment of the mineral in cold hydrochloric acid and add an excess of water to the solution; a white precipitate indicates the presence of bismuth. Bismuth minerals heated on charcoal with a mixture of potassium

[1] Hess, F. L., Bismuth: U. S. Geol. Survey Mineral Resources, 1913, pt. 1, p. 287, 1914.

iodide and sulphur give a brilliant scarlet incrustation. Some of the principal minerals of bismuth and their occurrences in the United States are reported by Hess,[2] by Emmons,[3] and by the writer.[4]

## PRICES.

The prices quoted in the American trade journals during 1922 ranged from $1.50 a pound in January to $2 in March, continued at $2 until September 23, and thereafter ranged between $2.20 and $2.45 to the end of the year.

## MARKETING.

The marketing of metallic bismuth has been interestingly described by Brush[5].

It is stated that in normal times bismuth ores and concentrates without other metals should contain at least 15 per cent of metallic bismuth to be marketable. It is doubtful whether the market is capable of absorbing large quantities from new sources of supply. The market is controlled by a syndicate in London, and all producers of rich bismuth ores and slimes are in one way or another subject to settlement for their product based on prices quoted for bismuth by this syndicate and published in foreign trade journals.

## WORLD'S RESOURCES.

### PRODUCTION.

As the bismuth market in the United States closely follows that of London, and as the American prices quoted are merely an expression in dollars and cents of the prices fixed in London,[6] with due allowance for foreign exchange and import costs, a properly balanced review of the bismuth resources and industry in the United States should include information on foreign resources. American bismuth, according to Brush, competes mainly with that sold in England, Germany, and Australia, and the principal foreign producers of bismuth ore are Australia, Bolivia, Peru, Mexico, Spain, Germany, and China. Available notes and statistics on these countries and on Russia, South Africa, India, and Japan, follow the table of world's production.

The table of world's production, however, which is compiled from official reports, lacks data on Mexico and China. Although complete figures for certain other countries are not available, it is doubtful if the output of any foreign country, expressed in terms of metallic bismuth, equals that of the United States.

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[2] Hess, F. L., U. S. Geol. Survey Mineral Resources, 1914, pt. 1, p. 965, 1916. For other sources of bismuth see Mineral Resources, 1913, pt. 1, p. 286, 1914.

[3] Emmons, W. H., The enrichment of ore deposits: U. S. Geol. Survey Bull. 625, pp. 411–417, 1917.

[4] U. S. Geol. Survey Mineral Resources, 1920, pt. 1, pp. 57–59, 1921.

[5] Brush, H. M., The marketing of bismuth: Eng. and Min. Jour.-Press, vol. 115, p. 272, Feb. 10, 1923.

[6] Brush, H. M., op. cit.

*World's production of bismuth ore and metal, 1913–1921, in kilograms.*

| Country. | 1913 | 1914 | 1915 | 1916 | 1917 | 1918 | 1919 | 1920 | 1921 |
|---|---|---|---|---|---|---|---|---|---|
| ORE.[a] | | | | | | | | | |
| Australia: | | | | | | | | | |
| New South Wales[b] | 9,144 | 15,241 | 18,289 | 30,481 | 20,321 | 31,497 | 19,305 | 77,219 | 8,128 |
| Northern Territory | (c) | (c) | (c) | (c) | (c) | 57 | (c) | 127 | ..... |
| Queensland (bismuth and wolfram concentrate) | 184,920 | 196,096 | 250,962 | 139,198 | 133,101 | 115,829 | 142,246 | 49,786 | ..... |
| Tasmania | 5,131 | 5,690 | 5,588 | 3,556 | 4,267 | 4,674 | 1,798 | 102 | 51 |
| Western Australia (exports) | ..... | 9,144 | 1,016 | 254 | 508 | ..... | 51 | ..... | ..... |
| Austria | ..... | ..... | 602,400 | 325,000 | (c) | (c) | (c) | (c) | (c) |
| Bolivia: | | | | | | | | | |
| Concentrates | 422,484 | 437,751 | 474,826 | 446,540 | 58,245 | 75,569 | 38,289 | 27,014 | 4,708 |
| Ores | ..... | 111,917 | 181,502 | 168,100 | 121,060 | 111,523 | 93,830 | 153,005 | 23,942 |
| Residues | ..... | ..... | 6,237 | 53,786 | 100,137 | 53,998 | 72,506 | 63,175 | ..... |
| British India | ..... | ..... | ..... | ..... | (d) | ..... | ..... | ..... | ..... |
| Germany (Saxony): | | | | | | | | | |
| Bismuth ores | 51,477 | 57,552 | 45,934 | 374,011 | 49,337 | 113,171 | 66,318 | 30,723 | 26,979 |
| Bismuth-cobalt-nickel ores | 165,500 | 161,250 | 150,500 | 117,750 | 133,250 | 155,875 | 121,815 | 131,250 | 133,875 |
| Tin-bismuth ores | ..... | ..... | ..... | ..... | ..... | 31,000 | 8,963 | 1,088 | 265 |
| Japan | b315 | b3,566 | b10,132 | b1,129 | b1,748 | 934 | 450 | (d) | (d) |
| Norway | ..... | ..... | 10,000 | ..... | 10,000 | 1,000 | ..... | ..... | ..... |
| Peru (exports) | (d) | (d) | ..... | ..... | (d) | ..... | ..... | (d) | (c) |
| Rhodesia (Northern) | ..... | ..... | ..... | 372 | ..... | 581 | ..... | 1,216 | ..... |
| Spain | 56,000 | 40,000 | 16,050 | 10,860 | 13,900 | 33,500 | 75,000 | 53,300 | 54,000 |
| Union of South Africa | ..... | ..... | ..... | ..... | ..... | ..... | 336 | ..... | ..... |
| United States | (e) | (e) | (e) | (e) | (e) | (e) | (e) | (e) | (e) |
| METAL. | | | | | | | | | |
| Australia: | | | | | | | | | |
| New South Wales | (f) | (f) | (f) | (f) | (f) | (f) | (f) | (f) | (f) |
| Northern Territory | (c) | (c) | (c) | (c) | (c) | (g) | (c) | (g) | ..... |
| Queensland | 1,626 | 864 | 2,540 | 3,556 | 4,064 | 1,118 | 2,032 | 965 | 25 |
| Tasmania | (g) | (g) | (g) | (g) | (g) | (g) | (g) | (g) | (g) |
| Western Australia | ..... | (g) | (g) | (g) | (g) | ..... | (g) | ..... | ..... |
| Austria | ..... | ..... | (g) | (g) | (c) | (c) | (c) | (c) | (c) |
| Bolivia | ..... | ..... | ..... | ..... | 255,238 | 248,983 | 169,451 | 194,537 | ..... |
| British India | ..... | ..... | ..... | ..... | 254 | ..... | ..... | ..... | ..... |
| Germany (Saxony) | (g) | (g) | (g) | (g) | (g) | (g) | (g) | (g) | (g) |
| Japan | (f) | (f) | (f) | (f) | (f) | 733 | 349 | 224 | 746 |
| Norway | ..... | ..... | (g) | ..... | (g) | (g) | ..... | ..... | ..... |
| Peru (exports) | 25,300 | 11,187 | ..... | ..... | 1,357 | ..... | ..... | 7,820 | (c) |
| Rhodesia (Northern) | ..... | ..... | ..... | (g) | ..... | (g) | ..... | (g) | ..... |
| Spain | (g) | (g) | (g) | (g) | (g) | 12,000 | 20,000 | 25,000 | 22,000 |
| Union of South Africa | ..... | ..... | ..... | ..... | ..... | ..... | (g) | ..... | ..... |
| United States | (e) | (e) | (e) | (e) | (e) | (e) | (e) | (e) | (e) |

[a] In addition to the countries listed, Argentina reports rail shipments as follows: 1916, 18,800 kilograms; 1917, 275,660 kilograms; 1918, 28,000 kilograms; a large part and probably all of this ore, however, is Bolivian. Hungary reports for 1917 a production of 7,158 quintals (715,800 kilograms) of ore; and from Madagascar 126 kilograms of bismuth was exported during 1913.

[b] Ore and metal combined; figures not shown separately.

[c] No data available.

[d] Metal reported.

[e] Geological Survey not at liberty to publish figures of production.

[f] Ore and metal combined; reported under ore.

[g] Ore reported.

SOURCES OF INFORMATION.

Australia: New South Wales, Dept. Mines Ann. Repts.; Northern Territory, official questionnaire by Warden of Mines; Queensland, Under Sec. Mines Ann. Rept.; Tasmania, Sec. Mines Rept.; Western Australia, Dept. Mines Rept.

Austria: Statistik des Bergbaus in Oesterreich.

Bolivia: Comercio especial.

British India: Geol. Survey Rec.

Germany (Saxony): Jahrbuch für das Berg- und Huttenwesen im Konigreich Sachsen.

Japan: 1913–1917, Résumé statistique; 1918–1919, Min. Industry, Bur. Mines; 1920, Bur. Mines official questionnaire; 1921, Consular report, Sept. 1, 1922.

Norway: Bergverksdrift Offisielle Statistikk.

Peru: Boletín del Cuerpo de Ing. de Minas del Perú; Estadística minera.

Rhodesia (Northern): Chamber of Mines.

Spain: Estadística minera de España.

Union of South Africa, Dept. Mines and Industries Ann. Repts.

## NORTH AMERICA.

*Mexico.*—Bismuth is widely distributed in Mexico, but no production was recorded in 1921 or 1922. The principal sources are the Bismuth King mine, operated by Americans in the Cosala district, near the eastern boundary of Sinaloa. Much of the bismuth ore produced in Mexico is said to have been taken from the Belen mine, in the southwestern part of Sonora, and from the Mariposa mine, in Sinaloa. Shipments of bismuth ore were made in 1908 from the Cananea copper district, in northern Sonora. Other sources are the oxidized bismuth ores found near Ojo, in north-central Chihuahua. Bismuth ocher has been noted in the nickel-cobalt deposits found in the Pihuamo mine, in southeastern Jalisco. Bismuth also is reported as occurring in the El Doctor mine, in Queretaro, and with silver ore in the Andesire mine, in Cerro del Carmen, Durango.

## SOUTH AMERICA.

*Bolivia.*—A statement covering the operations in 1921 of the largest producer of bismuth in Bolivia[6a] reported the output of 20,328 kilograms (44,816 pounds) of bars and flue dust from mineral previously extracted and 9,103 kilograms (20,069 pounds) of rich ore from Tasna. The American consul at La Paz reported that the total Bolivian output of bismuth concentrate produced and exported amounted to 10,379 pounds, containing an average of 62 per cent of bismuth, and the ore amounted to 52,783 pounds, containing 20 per cent of bismuth.

The bismuth ores found in Bolivia are associated with cassiterite-bearing veins in the eastern Andes, but they are not so widely distributed as the tin ore. The bismuth-bearing veins have resulted from a complex local phase of the more widespread tin mineralization. The chief producing mines are those of the Compagnie Aramayo de Mines en Bolivie, at Tasna and Chorolque, and the Carmen mine, at Huayni Potosi (north of La Paz). The Carmen mine is particularly noteworthy on account of the abundant occurrence of native bismuth there, but elsewhere the prevailing mineral is the sulphide, bismuthinite. Bismuth ocher is found in the oxidized ores, and the chief associated vein minerals are cassiterite, wolfram, pyrite, pyrrhotite, and chalcopyrite.

Crude metallic bismuth, amounting to 245 tons, was exported from Bolivia in 1918, in addition to certain quantities of concentrates and ore. The total output in 1919 and 1920 reported by the American consul at La Paz was as follows:

*Bismuth produced in Bolivia, 1919–1920.*

| | Average bismuth content (per cent). | 1919 | | 1920 | |
|---|---|---|---|---|---|
| | | Kilograms. | Value (bolivianos). | Kilograms. | Value (bolivianos). |
| Bismuth bars | 80 | 169,451 | 2,211,335 | 194,537 | 2,541,853 |
| Concentrates | 60 | 38,289 | 248,703 | 27,014 | 175,385 |
| Residues | 30 | 72,506 | 315,401 | 63,175 | 274,811 |
| Ores | 20 | 93,830 | 306,204 | 153,005 | 500,532 |

[6a] Compagnie Aramayo de Mines en Bolivie: Min. Jour. (London), vol. 138, p. 599, July 29, 1922.

*Peru.*—The San Gregorio mine[7] of the Cerro de Pasco district, owned by E. E. Fernandini, is the principal bismuth mine in Peru and the only one that has been worked. Records show that the exportation of concentrate containing 20 per cent of bismuth began in 1907.

*Bismuth in concentrate exported from Peru, 1907–1917.*[7a]

| | Kilograms. | | Kilograms. | | Kilograms. |
|---|---|---|---|---|---|
| 1907 | 12,800 | 1910 | 24,136 | 1913 | 25,300 |
| 1908 | 8,586 | 1911 | 24,431 | 1914 | 11,187 |
| 1909 | 30,300 | 1912 | 51,038 | 1917 | 1,357 |

The ore mined is reported to contain 1.5 to 2 per cent of bismuth and is reduced in the Huaraucaca works to a 20 per cent bismuth concentrate. In May, 1920, the concentrate smelted at these works produced 189 bars of bismuth 80 to 92 per cent pure. The bars exported that year contained 7,820 kilograms of bismuth.

## EUROPE.

*Germany.*—Native bismuth and other bismuth minerals are found in the silver and cobalt-silver lodes of the Schneeberg district, in Saxony, where the veins are in greisen, and in the Johanngeorgenstadt district, where the lodes occur in mica schist, the result of metamorphism by intrusive granite.

*Spain.*—In 1921 Spain made an output of 54 metric tons of bismuth ore and 22 tons of metallic bismuth.[8] Though bismuth is known to occur in the copper ores of the Rio Tinto mines, no recovery is reported.

## AFRICA.

*South Africa.*—Gold ore of the Sabi district and tin ore of the Stavoren district, South Africa, contain bismuth, but neither occurrence is of commercial importance.[9] In 1897 a rich mass of bismutite was found on the Geweerfontein farm, in the Bushveld granite area of Transvaal. The deposit was worked out in 60 feet and abandoned until recently, when work was recommenced in the hope of again finding the ore. In 1919 a small quantity of bismuth, valued at $1,500, was produced, but none since.

## ASIA.

*China.*—The chief source of bismuth (ore) in China has been the Kityang district, in the vicinity of Wukingfu.[10] The Yung Hua Co. has the mining rights for the Wukingfu field. The bismuth ore exported in 1919 amounted to 118,000 pounds, valued at $43,915, in 1920 to 199,467 pounds,[11] and in 1921 to 265,733 pounds.

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[7] Fuchs, F. C., The mining industry of Peru: Eng. and Min. Jour., vol. 103, p. 1011, June 9, 1917.

[7a] Cuerpo ing. minas Perû Bol.; Estadistica minera.

[8] Estadística minera de España.

[9] Pisar, C. J. (American vice-consul, Cape Town), report, Mar. 8, 1922 (U. S. Geol. Survey Cons. file, No. 4201).

[10] Myers, M. S. (American consul, Swatow), report, Mar. 6, 1922 (U. S. Geol. Survey Cons. file, No. 4140).

[11] China Maritime Customs, Foreign trade of China, 1920, Statistical ser., Nos. 2–5, pt. 1, p. 16, 1921.

*India.*—The only part of India where bismuth ores are abundant is in the Tenasserim division of Lower Burma,[12] but they have been mined only on a small commercial scale.

Traces of bismuth are known to occur in some of the copper ores of the Singhbhum district. In the Tavoy district both native bismuth and the sulphide, bismuthinite, occur in the wolfram and tinstone bearing veins in the region of Kanbauk, Kalonta, Zinba, and Putletto. Bismuth is also found in the Mergui and Amherst districts. * * * The veins traverse both sedimentary rocks and the granites which have been intruded into them. * * * The small amount of bismuth exported from Burma up to the present time (1921) has been recovered as a by-product in the sluicing of alluvial deposits for wolfram and tinstone [bismuthinite]. * * * The bismuth minerals are either hand picked out of the clean concentrates after sluicing operations or recovered chemically from the tin ores after magnetic separation. The chemical process is not carried out in India but is known to have been performed on certain Tavoyan tin ores after their arrival in the United Kingdom.

*Russia.*—A recent discovery of bismuth in Transbaikal, Siberia, was reported in 1922,[13] and also a new bismuth mineral that is called "bazovismutit" (base bismutite) and contains 60 per cent of bismuth, found by K. A. Nenadkevich, in the Zabaykalye region.

*Japan.*—Bismuth was discovered recently in Japan, but only a small quantity has been mined. An output of bismuth amounting to 1,644 pounds, valued at 4,786 yen, was made in 1921, against 497 pounds, valued at 2,984 yen, in 1920.[14]

## OCEANIA.

*Australia.*—Bismuth is found in New South Wales at Kingsgate, near Glen Innes, and at Jingera, near Pambula. The occurrence of the minerals in Australia is described in a recent report,[15] in part as follows:

Both the metal and the sulphide occur in veins, pipes, and pegmatites with molybdenite and wolfram. In Queensland, at Mount Shamrock, native bismuth and its sulphide and telluride occur with gold in irregular impregnations and veins in a volcanic breccia. The Burnett district, at Mount Biggenden, has the most important deposit, in which native bismuth and its sulphide are irregularly disseminated through a mass of magnetite, associated with basic rocks, shales, tuffs, and limestones of Permo-Carboniferous age. In the Chillagoe and Herberton fields native metal, sulphide, oxide, and carbonate, associated with wolfram, molybdenite, and other minerals, occur in veins, pipes, and impregnations in granite, greisen, schist, and slate. Wolfram and molybdenite are mined, and the bismuth ores are recovered as by-products.

Since the working of wolframite and molybdenite ores has decreased, the production of bismuth, which was a by-product of these two minerals, has decreased also.

The bismuth ore and metal produced in New South Wales in 1920 amounted to 77 tons, valued at £33,886,[16] but only 8 tons, valued at £912, was produced in 1921. The bismuth mineral is found in association with molybdenite, but as there has been no market for molyb-

[12] Brown, J. C., Notes on antimony, arsenic, and bismuth: Bull. Indian Industries and Labor, No. 6, p. 28, Calcutta, India, 1921.

[13] Davis, L. A. (American consul, Helsingfors, Finland), report; also Young, Evan (American commissioner, Riga, Latvia), report, giving translations of Moscow Economic Life, No. 210, Sept. 19, 1922.

[14] Kirjassoff, M. D. (American consul, Yokohama), report, Sept. 1, 1922 (U. S. Geol. Survey Cons. file, No. 4171).

[15] Brown, J. C., Notes on antimony, arsenic, and bismuth: Bull. Indian Industries and Labor, No. 6, p. 28, Calcutta, India, 1921.

[16] New South Wales Dept. Mines Ann. Rept. for 1921, Sydney, 1922.

denite, the production of bismuth has ceased. The bismuth has been mined in the Dalmorton, Glen Innes, Oberon, Tenterfield, and Torrington divisions.

## USES.

Bismuth is used principally in medicinal chemicals, and until recently all bismuth compounds required for industrial purposes were prepared in the Saxon works at Schneeberg, Germany. Certain fusible alloys that melt at comparatively low temperatures contain a large percentage of bismuth, together with lead and tin, with or without cadmium and other metals. Wood's metal, in addition to its other uses, was in large demand in 1922 for an important part of radio equipment. Other alloys are D'Arcet's metal, Guthrie's metal, Lipowitz's metal, Newton's metal, Onion's alloy, and Rose's metal. All these metals and alloys contain 47 per cent or more of bismuth and melt below the boiling point of water. Wire made of bismuth is useful in plotting the intensity of magnetic fields, in making resistance tests, and in measuring small intensities of heat and light. Until recently this wire was made in other countries. Bismuth alloys are also used in making safety plugs for boilers, automatic fire extinguishers, fuses for hand grenades, electrical apparatus, dental amalgams, and electrotype molds.

# SELENIUM.

By V. C. Heikes.

The output of selenium reported by three companies in 1922 was 113,515 pounds. This output with some selenium on hand made an available supply of 123,565 pounds, all of which was sold in 1922 for $177,542, or an average of $1.44 a pound. The largest producer in 1922 was the American Smelting & Refining Co., which controls, through stock ownership, the Baltimore Copper Works, near Baltimore, Md. Selenium was also recovered at Chrome, N. J., in the electrolytic copper refinery of the United States Metals Refining Co., a subsidiary of the American Metal Co., and at Perth Amboy, N. J., in the Raritan electrolytic copper refinery of the Anaconda Copper Co.

*Selenium produced in the United States and sold, 1917–1922.*

| Year. | Pounds. | Value. | Year. | Pounds. | Value. |
|---|---|---|---|---|---|
| 1917 | 39,630 | $70,000 | 1920 | 92,141 | $175,508 |
| 1918 | 103,694 | 206,540 | 1921 | 55,978 | 89,148 |
| 1919 | 60,025 | 125,966 | 1922 | 123,565 | 177,542 |

Glass manufacturers in the United States purchased part of the selenium sold in 1922, and glass manufacturers in England and Germany increased their purchases. A decided decrease in the output of selenium is expected from one of the large copper refineries in 1923, as the anode mud is now practically free from selenium, probably owing to the discontinued treatment of certain ores. The quantity of selenium contained in blister copper is shown by Hess [1] in an earlier report, in which many occurrences are cited.

Though selenium is still being used in the manufacture of "ruby" glass, the chief function of selenium in the glass industry is that of a decolorizer, to offset the green color of the glass due to iron.

During 1922 the prices quoted for selenium in the form of amorphous powder were $2 to $2.25 a pound from January until July, when the price dropped to $1.75 bid and $1.85 asked. This price continued until August 26 and then increased to $1.90 until December 23, when the price was restored to $2 a pound. Early in 1922 selenium was quoted in London at 7s. 9d. a pound.

[1] Hess, F. L., U. S. Geol. Survey Mineral Resources, 1914, pt. 1, p. 971, 1916.

*Selenium and selenium salts imported for consumption in the United States, 1916–1922.*

| Year. | Value. | Year. | Value. |
|---|---|---|---|
| 1916 | $302 | 1920 | |
| 1917 | 2,236 | 1921 | $2,099 |
| 1918 | | 1922 | 2,530 |
| 1919 | 25,866 | | |

# TELLURIUM.

By V. C. Heikes.

Nearly all the metallic tellurium produced in 1922 was sold to manufacturers of electrical equipment. Two producers, the Raritan Copper Works and the United States Smelting, Refining & Mining Co., reported a production in 1922 about 25 per cent larger that that of 1921. Nearly all the output was sold at a price varying from $1.25 to $2 a pound, though quotations ranged from $2 to $2.50 a pound.

In common with many other substances, tellurium has been found to work admirably as a crystal detector in radio work. The sale of tellurium for that purpose has been large,[1] and though the rapidity with which the wireless industry is being developed forbids any prophesy as to the future use of tellurium for that purpose, it is interesting to note that this is the first technical application of tellurium on a commercial scale.

A market for the entire output of tellurium in the United States is a possibility in the development of its use in treating fuels for internal-combustion engines, particularly airplane motors. The discovery of its usefulness for this purpose made by Thomas Midgley and Thomas Boyd, of the General Motors Corporation, has been extensively noted.[2] The addition of one part by weight of diethyl telluride in 10,000 parts of gasoline is said to increase the efficiency of a special type of the internal-combustion engine by 20 per cent. This discovery was made during the investigation of antiknock compounds for automobile engines, and the effect of tellurium for that purpose is remarkable.

[1] Skowronski, S., Mineral Industry for 1921, p. 619.

[2] General information concerning tellurium may be obtained from U. S. Bur. Mines Repts. Inv. No. 2385, August, 1922, and from Mineral Industry, published by the McGraw-Hill Publishing Co. See also Lenher, Victor, Selenium and tellurium: Sci. Am. Monthly, June, 1921, p. 552.

# LEAD.[1]

By C. E. Siebenthal and A. Stoll.

## SUMMARY.

*Statistics of refined lead, 1921 and 1922, in short tons.*

| | 1921 | 1922 |
|---|---|---|
| PRODUCTION. | | |
| Domestic desilverized lead | 187,962 | 185,191 |
| Domestic soft lead | 157,513 | 209,250 |
| Domestic desilverized soft lead | 52,747 | 74,305 |
| | 398,222 | 468,746 |
| Foreign desilverized lead | 50,367 | 63,916 |
| Total refined primary [a] lead | 448,589 | 532,662 |
| Antimonial lead | 10,064 | 8,075 |
| Secondary lead [a] | 103,780 | 159,560 |
| CONSUMPTION.[b] | | |
| Apparent consumption of primary lead, stocks disregarded | 444,872 | 492,705 |

[a] "Primary lead," which is produced directly from ore, is here distinguished from "secondary lead," which is obtained by refining skimmings, drosses, and old metals. The statistics of secondary lead are given on p. 29. In this report the word "lead" used without qualification means primary lead.
[b] For method of calculating consumption see p. 34.

The output of refined lead in the United States from domestic ores in 1922 was 468,746 short tons, valued at $51,562,000 at the average selling price of pig lead, a gain, as compared with 1921, of 18 per cent in quantity and of 44 per cent in value.

## PRODUCTION.

*Quantity and value.*—The refined lead produced in the United States from 1720 to 1914 from domestic ores and from foreign ores and base bullion and its value at the average price in New York are shown in a table in the chapter on lead in Mineral Resources for 1914; details for later years are shown in the annual chapters.

*Refined lead produced in the United States, 1917–1922.*

| Year. | Quantity (short tons). | | | | | | Value. | |
|---|---|---|---|---|---|---|---|---|
| | Desilverized lead.[a,b] | Soft lead.[c] | Total production.[b] | From domestic ores and base bullion.[b] | From foreign ores. | From foreign base bullion. | Average per pound. | Total. |
| 1917 | 422,266 | 188,503 | 610,769 | 548,450 | 15,872 | 46,447 | $0.086 | $105,052,000 |
| 1918 | 429,732 | 210,463 | 640,195 | 539,905 | 15,334 | 84,956 | .071 | 90,908,000 |
| 1919 | 334,476 | 147,744 | 482,220 | 424,433 | 7,656 | 50,131 | .053 | 51,115,000 |
| 1920 | 339,803 | 189,854 | 529,657 | 476,849 | 8,414 | 44,394 | .08 | 84,745,000 |
| 1921 | 291,076 | 157,513 | 448,589 | 398,222 | 7,110 | 43,257 | .045 | 40,373,000 |
| 1922 | 323,412 | 209,250 | 532,662 | 468,746 | 13,898 | 50,018 | .055 | 58,593,000 |

[a] Desilverized soft lead is included; for quantity, see p. 28.
[b] Antimonial lead is excluded; for quantity, see p. 29.
[c] Desilverized soft lead is excluded.

[1] Chapters on lead giving more than ordinary detail were published in Mineral Resources for 1908 (historical table of production) and 1918 (the lead industry in relation to the World War).

*Production by States.*—In addition to the domestic lead ores smelted in this country, small quantities of domestic lead ore have been exported to smelters in Canada. In 1917 silver-lead ores from Idaho and Montana smelted in Canada produced 4,570 tons of lead. Ores from Washington yielded 1,388 tons of lead at Canadian smelters in 1918 and 3 tons in 1919, but no lead ore from the United States was treated in Canada in 1920–1922.

*Primary lead smelted or refined in the United States, 1917–1922, by sources, in short tons.*

| Source of ore. | 1917 | 1918 | 1919 | 1920 | 1921 | 1922 |
|---|---|---|---|---|---|---|
| Domestic ore: | | | | | | |
| Alaska | 884 | 531 | 645 | 591 | 773 | 324 |
| Arizona | 7,456 | 6,195 | 5,407 | 5,987 | 3,313 | 7,218 |
| Arkansas [a] | 300 | 14 | | | | |
| California | 11,471 | 6,228 | 2,004 | 2,260 | 614 | 3,018 |
| Colorado | 29,327 | 29,395 | 18,867 | 17,752 | 12,104 | 11,108 |
| Idaho | 174,045 | 142,640 | 89,091 | 117,191 | 99,707 | 91,487 |
| Illinois [a] | 867 | 1,010 | 977 | 948 | 271 | 750 |
| Kansas [a] | 2,663 | 5,023 | 7,951 | 8,421 | 10,939 | 10,900 |
| Kentucky [a] | 21 | 109 | 83 | 114 | 41 | 73 |
| Missouri [a] | 218,197 | 187,743 | 150,341 | 171,999 | 151,028 | 202,245 |
| Montana | 5,933 | 17,586 | 17,513 | 13,231 | 11,565 | 14,551 |
| Nevada | 12,334 | 8,726 | 5,958 | 8,650 | 3,553 | 4,264 |
| New Hampshire | | | 16 | | | |
| New Mexico | 3,428 | 5,140 | 1,418 | 1,123 | 384 | 1,230 |
| New York | | 49 | | | | |
| Oklahoma [a] | 19,646 | 58,755 | 49,984 | 68,494 | 46,902 | 67,436 |
| Oregon | | 6 | | | | |
| South Dakota | 34 | 28 | 18 | 6 | 2 | 2 |
| Tennessee [a] | | 843 | 2,371 | 2,705 | | 751 |
| Texas | 58 | 30 | 8 | 1 | 1 | |
| Utah | 82,081 | 76,169 | 65,102 | 64,006 | 51,872 | 63,130 |
| Virginia [a] | 147 | 59 | | | | |
| Washington | 929 | 906 | 1,090 | 2,460 | 325 | 478 |
| Wisconsin [a] | 2,930 | 4,275 | 3,975 | 3,841 | 1,079 | 1,323 |
| Undistributed | 145 | 59 | 119 | 201 | 101 | 117 |
| Zinc residues | 6,489 | 5,359 | 4,887 | 4,366 | 713 | 1,284 |
| | 579,385 | 556,878 | 427,825 | 494,347 | 395,287 | 481,689 |
| Foreign ore: | | | | | | |
| Africa | 1,738 | 1,519 | 644 | 1,171 | | |
| Australia | | 282 | 69 | 450 | | |
| Canada | 1,100 | 7,550 | 1,895 | 1,186 | 2,877 | 3,604 |
| Central America | | | 12 | 22 | 6 | 14 |
| Mexico | 7,607 | 4,798 | 2,261 | 2,729 | 1,912 | 7,260 |
| South America | 1,533 | 1,101 | 2,537 | 2,747 | 2,235 | 2,458 |
| Other foreign | 3,894 | 84 | 238 | 109 | 90 | 562 |
| Foreign base bullion: | | | | | | |
| Canada | 6,750 | 8,108 | 567 | 1,919 | 1,599 | 2,900 |
| Mexico | 39,508 | 76,809 | 49,564 | 42,421 | 41,648 | 47,118 |
| South America | 189 | 39 | | 54 | | |
| | 62,319 | 100,290 | 57,787 | 52,808 | 50,367 | 63,916 |
| Grand total | 641,704 | 657,168 | 485,612 | 547,155 | 445,654 | 545,605 |

[a] The lead produced by these States is nonargentiferous or soft lead.

*Soft lead.*—The lead ores of the Mississippi Valley are almost free from silver, and the lead produced from them is known as "soft lead."

*Soft lead produced in the United States, 1917–1922, in short tons.*

| Year. | Soft pig lead. | | | Soft lead recovered in pigments. | Total soft lead. | Total domestic lead.[a] | Soft lead percentage of total domestic lead. |
|---|---|---|---|---|---|---|---|
| | Undesilverized. | Desilverized. | Total. | | | | |
| 1917 | 188,503 | 56,268 | 244,771 | 12,870 | 257,641 | 574,338 | 45 |
| 1918 | 210,463 | 47,418 | 257,881 | 13,093 | 270,974 | 562,218 | 48 |
| 1919 | 147,744 | 67,938 | 215,682 | 11,479 | 227,161 | 444,250 | 51 |
| 1920 | 189,854 | 66,668 | 256,522 | 15,960 | 272,482 | 500,841 | 54 |
| 1921 | 157,513 | 52,747 | 210,260 | 10,158 | 220,418 | 415,055 | 53 |
| 1922 | 209,250 | 74,305 | 283,555 | 13,892 | 297,447 | 488,448 | 61 |

[a] Includes domestic refined lead, domestic lead in antimonial lead, and domestic lead in pigments.

*Antimonial lead.*—The production of by-product antimonial lead from argentiferous lead ores derived from all sources, as reported by all lead refineries operating in this country, is shown for the period 1871–1914 in Mineral Resources, 1914, and for 1915–1920 in Mineral Resources, 1920.

*By-product antimonial lead produced in the United States, 1917–1922*

| Year. | Total lead refined from base bullion (short tons). | Percentage of by-product antimonial lead. | Antimonial lead. | | | | | | |
|---|---|---|---|---|---|---|---|---|---|
| | | | From domestic ore (short tons). | From foreign ore short tons). | Total. | | | | |
| | | | | | Short tons. | Value. | Antimony content. | | Lead content, by difference (short tons). |
| | | | | | | | Short tons. | Percentage. | |
| 1917 | 365,998 | 5.1 | 15,279 | 3,367 | 18,646 | $3,781,560 | 2,759 | 14.8 | 15,887 |
| 1918 | 382,314 | 4.9 | 10,777 | 7,793 | 18,570 | 2,826,350 | 2,566 | 13.8 | 16,004 |
| 1919 | 266,538 | 5.2 | 9,674 | 4,200 | 13,874 | 1,513,968 | 1,943 | 14.0 | 11,931 |
| 1920 | 273,135 | 4.6 | 9,604 | 2,931 | 12,535 | 1,963,255 | 2,033 | 16.2 | 10,502 |
| 1921 | 238,329 | 4.2 | 7,881 | 2,183 | 10,064 | 870,059 | 1,589 | 15.8 | 8,475 |
| 1922 | 249,107 | 3.2 | 7,068 | 1,007 | 8,075 | 844,993 | 1,441 | 17.8 | 6,634 |
| Average | | 4.61 | | | | | | 15.1 | |

*Lead pigments.*—Leaded zinc oxide, zinc-lead oxide, sublimed white lead, and sublimed blue lead are made directly from ore. Each of these pigments is discussed and the output given elsewhere in this volume in the chapter on lead and zinc pigments and salts. The lead content of pigments smelted directly from ore is given in the fourth column of the last table on page 28. The pigments manufactured from pig lead (white lead, red lead, orange mineral, and litharge) are also discussed and the output given in the chapter on lead and zinc pigments.

*Secondary lead.*—Secondary lead is obtained mainly from skimmings, drosses, old metal, and alloys, such as babbitt, solder, and type metal. The recovery of lead by refining these materials constitutes an integral part of the lead industry.

*Secondary lead recovered in the United States, 1917–1922, in short tons.*

| Year. | Pig lead. | Lead in alloys. | Total recovered lead. | Value. |
|---|---|---|---|---|
| 1917 | 45,100 | 48,400 | 93,500 | $16,082,000 |
| 1918 | 41,146 | 55,954 | 97,100 | 13,788,000 |
| 1919 | 55,684 | 66,416 | 122,100 | 12,943,000 |
| 1920 | 56,350 | 68,300 | 124,650 | 19,944,000 |
| 1921 | 46,370 | 57,410 | 103,780 | 9,340,000 |
| 1922 | 75,480 | 84,080 | 159,560 | 17,552,000 |

*Mine production.*—The preceding tables give the quantity of lead recovered by smelting and refining operations either as metallic lead, or in the alloy antimonial lead, or as lead in pigments. The origin of the lead is much more accurately shown by the reports of mines, because smelters necessarily treat mixtures of ores, sometimes long

after they have been received, so that the actual output of metallic lead may not correspond at all closely to the product of the mines for the same year.

The following table gives the mine output of lead since 1917. Figures of mine production for 1907–1918, inclusive, are given on page 946 of the chapter on lead in Mineral Resources for 1918.

*Mine production of lead by States, 1917–1922, in short tons.*

| State. | 1917 | 1918 | 1919 | 1920 | 1921 | 1922 |
|---|---|---|---|---|---|---|
| Alaska | 852 | 564 | 687 | 875 | 759 | 377 |
| Arizona | 11,733 | 6,252 | 5,102 | 7,300 | 3,271 | 7,535 |
| Arkansas | 382 | 120 | 28 | 8 | 21 | 42 |
| California | 10,934 | 6,686 | 1,784 | 2,407 | 562 | 3,156 |
| Colorado | 33,995 | 32,980 | 18,535 | 23,315 | 9,830 | 11,739 |
| Georgia | | | | 2 | | 4 |
| Idaho | 196,780 | 147,348 | 91,171 | 124,805 | 99,235 | 97,917 |
| Illinois | 1,439 | 2,273 | 2,105 | 1,743 | 672 | 1,325 |
| Iowa | 34 | | | | | |
| Kansas | 3,025 | 7,252 | 11,283 | 16,788 | 18,679 | 23,271 |
| Kentucky | 123 | 185 | 86 | 122 | 69 | 92 |
| Maine | | | 1 | | | |
| Massachusetts | | | | 14 | | |
| Missouri | 234,156 | 194,175 | 163,290 | 165,114 | 180,085 | 178,412 |
| Montana | 10,976 | 18,568 | 17,219 | 15,627 | 10,183 | 14,884 |
| Nevada | 13,839 | 11,658 | 7,675 | 10,632 | 3,594 | 4,695 |
| New Hampshire | 48 | 30 | | | | |
| New Mexico | 4,554 | 4,199 | 1,443 | 1,435 | 339 | 1,506 |
| New York | | 29 | | | | |
| North Carolina | 1 | | | | | |
| Oklahoma | 26,358 | 56,097 | 53,872 | 65,394 | 41,552 | 62,856 |
| Oregon | | 5 | | | | 38 |
| Pennsylvania | | | | 7 | | |
| South Dakota | 34 | 27 | 16 | 6 | 2 | |
| Tennessee | 2,531 | 1,705 | 2,188 | 1,979 | | 732 |
| Texas | 1 | 13 | 7 | | | 4 |
| Utah | 89,261 | 83,504 | 61,915 | 70,419 | 44,594 | 67,666 |
| Virginia | 859 | 815 | | | | |
| Washington | 4,895 | 2,636 | 1,073 | 2,894 | 72 | 691 |
| Wisconsin | 4,139 | 4,533 | 4,214 | 2,647 | 972 | 691 |
| | 650,949 | 581,654 | 443,694 | 513,533 | 414,491 | 477,633 |

## TRADE CONDITIONS.

### WORLD'S SMELTER PRODUCTION.

In the following table, prepared by W. I. Whiteside, of the United States Geological Survey, the figures in black-faced type are taken from the official statistics of the countries named; those in ordinary type, for years prior to 1922, are taken from the 1921 issue of the yearbook of the American Bureau of Metal Statistics, an association of the copper producers, the lead producers, and the principal zinc producers of this country. Those in ordinary type for 1922 are taken from the trade press. The official statistics will be substituted in this record as fast as they are made available.

There is always a possibility of duplication in figures showing world production, for some countries send "work lead" or base bullion to other countries for refining. Furthermore, secondary and antimonial lead are included in the figures showing the foreign production, so that to put the United States on an equal footing in the statistics it would be necessary to include in its production the domestic output of secondary lead and antimonial lead. The figures for the United States represent refined lead that was smelted in this country, whatever the source of the ore.

*World's smelter production of lead, 1913 and 1917–1922.*

[In metric tons, by countries where smelted, but not necessarily refined. Figures in black-faced type are official.]

| Country. | 1913 | 1917 | 1918 | 1919 | 1920 | 1921 | 1922 |
|---|---|---|---|---|---|---|---|
| Australia | **110,444** | **144,950** | **163,376** | **83,408** | **5,474** | **51,452** | 107,645 |
| Austria | **22,312** | **29,381** | **4,743** | **1,764** | **3,973** | **3,347** | 3,725 |
| Belgium | **53,590** | **22,745** | **20,630** | **4,225** | **16,040** | **29,750** | 36,000 |
| Canada | **17,202** | **20,709** | **17,005** | **16,143** | **13,733** | **28,274** | **40,798** |
| France | **28,817** | **21,235** | **12,778** | **10,928** | 12,000 | 10,000 | 12,000 |
| Germany: | | | | | | | |
| Upper Silesia | **41,300** | **32,960** | **23,960** | **18,580** | **18,008** | 13,743 | } 85,000 |
| Other Germany | **146,667** | **53,268** | **40,617** | **39,006** | 41,000 | 58,000 | |
| Great Britain | 18,420 | 11,430 | 11,083 | 10,441 | 11,136 | 5,241 | 3,000 |
| Greece | **18,309** | **1,422** | **4,093** | **3,841** | **5,016** | **5,575** | 4,700 |
| Hungary | **1,137** | 5,000 | (*a*) | (*b*) | (*b*) | (*b*) | (*a*) |
| India (Burma) | **5,951** | **17,233** | **19,380** | **19,396** | **24,203** | **34,258** | 39,843 |
| Italy | **21,674** | **16,237** | **18,332** | **16,530** | **15,947** | **12,494** | **10,500** |
| Japan | **3,777** | **15,807** | **10,684** | **5,771** | **4,167** | **3,138** | 3,000 |
| Mexico[c] | 57,488 | 39,005 | 83,705 | 76,384 | 82,480 | 58,586 | 114,235 |
| Poland | (*d*) | (*d*) | (*d*) | **636** | 1,500 | **1,010** | 1,000 |
| Rhodesia | **295** | **3,722** | **9,935** | **12,859** | **14,836** | **17,969** | 20,831 |
| Rumania | (*e*) | (*e*) | (*e*) | *f* **544** | *f* **601** | *f* **582** | (*a*) |
| Russia | **1,523** | (*a*) | (*a*) | (*a*) | (*a*) | (*a*) | (*a*) |
| South America | **2,476** | 4,148 | 4,781 | 6,565 | 6,264 | 4,664 | 5,937 |
| Spain | **198,829** | **176,309** | **169,709** | **125,721** | **175,196** | **135,881** | 97,000 |
| Sweden | **1,235** | **3,174** | **2,241** | **327** | **863** | **488** | **400** |
| Tunis | ..... | **18,590** | **16,533** | **5,800** | **11,407** | **12,225** | **13,200** |
| Turkey | 13,900 | 3,000 | 2,500 | 1,000 | 1,000 | 8,345 | 3,100 |
| United States (refined) | **385,643** | **511,942** | **503,702** | **391,982** | **440,221** | **367,718** | **437,845** |
| | 1,151,000 | 1,152,000 | 1,140,000 | 852,000 | 905,000 | 863,000 | 1,040,000 |

*a* Statistics not available.
*b* See Rumania.
*c* Mexican output as reported by American Bureau of Metal Statistics, less bullion smelted in the United States from Mexican ore.
*d* See Russia.
*e* See Hungary.
*f* Fiscal year, Apr. 1 of year given to Mar. 31 of following year.

## IMPORTS AND EXPORTS.

The following tables were compiled from the records of the Bureau of Foreign and Domestic Commerce by J. A. Dorsey, of the United States Geological Survey.

*Lead remaining in warehouse in the United States, Dec. 31, 1917–1922, in pounds.*

[Stated in the form in which the material was entered for warehouse.]

| | 1917 | 1918 | 1919 | 1920 | 1921 | 1922 |
|---|---|---|---|---|---|---|
| Ore and base bullion | 47,853,945 | 33,997,822 | 90,952,684 | 102,440,325 | 38,371,815 | (*a*) |
| Pigs, bars, and old | 5,370,445 | 944,483 | 468,154 | 2,644,576 | 693,440 | (*a*) |

*a* Figures not available.

*Lead imported and entered for consumption in the United States, 1917–1922.*

| Year. | Lead in ore. | | Base bullion. | | Pigs, bars, and old. | | Sheets, pipe, and shot. | | Not otherwise specified. | Total value. |
|---|---|---|---|---|---|---|---|---|---|---|
| | Pounds. | Value. | Pounds. | Value. | Pounds. | Value. | Pounds. | Value. | | |
| 1917 | 5,438,931 | $207,370 | 6,965,849 | $470,539 | 1,756,223 | $85,743 | 12,538 | $2,699 | $10,287 | $776,638 |
| 1918 | 6,064,902 | 344,080 | 3,559,071 | 180,070 | 1,139,950 | 56,694 | 6,892 | 624 | 36,723 | 618,191 |
| 1919 | 4,106,823 | 196,363 | 31,796,693 | 1,130,937 | 10,174,115 | 415,094 | 8,018 | 628 | 17,187 | 1,760,209 |
| 1920 | 13,700,499 | 908,619 | 66,816,820 | 3,340,600 | 68,901,959 | 3,887,821 | 81,396 | 5,483 | 21,328 | 8,163,851 |
| 1921 | 6,842,807 | 327,046 | 56,819,980 | 1,668,410 | 61,909,094 | 1,972,716 | 3,087 | 140 | 11,204 | 3,979,516 |
| 1922 | 23,649,851 | 812,603 | 55,859,422 | 1,815,142 | *a* 8,563,110 | *a* 335,924 | 6,018 | 697 | 12,286 | 2,976,652 |

*a* Includes also imports of antimonial lead, antimonial scrap lead, babbitt metal, solder, etc., in period Sept. 22–Dec. 31.

*Type metal imported and entered for consumption in the United States, 1917–1922.*

| Year. | Type metal. | | Lead content. | |
|---|---|---|---|---|
| | Pounds. | Value. | Pounds. | Percentage. |
| 1917 | | | | |
| 1918 | 551,794 | $35,938 | 513,166 | 93.0 |
| 1919 | 13,394,803 | 816,642 | 11,000,498 | 82.1 |
| 1920 | 29,887,353 | 1,349,495 | 25,761,543 | 86.2 |
| 1921 | 38,971,351 | 1,191,553 | 30,706,845 | 78.8 |
| 1922 | 43,365,120 | 1,082,832 | 32,785,042 | 75.6 |
| Average lead content, 1917–1922 | | | | 79.9 |

*General imports of lead into the United States, 1917–1922, by classes, in pounds.*

| Year. | Lead in ore. | Base bullion. | | Pigs, bars, sheets, and old. | Total lead content. |
|---|---|---|---|---|---|
| | | Gross weight. | Lead content. | | |
| 1917 | 41,292,876 | 109,279,997 | 103,664,970 | 11,585,974 | 156,543,820 |
| 1918 | 37,070,340 | 155,810,003 | 149,663,889 | 10,480,531 | 197,214,760 |
| 1919 | 19,573,856 | 115,317,160 | 112,024,518 | 10,214,753 | 141,813,127 |
| 1920 | 29,488,816 | 101,476,550 | 96,103,603 | 71,437,108 | 197,029,527 |
| 1921 | 14,234,039 | 77,882,834 | 71,733,838 | 62,602,534 | 148,570,411 |
| 1922 | 24,474,481 | (a) | 124,074,465 | 7,101,623 | 155,650,569 |

a Figures not available.

*General imports of lead into the United States, in ore, base bullion, and refined, 1917–1922, by sources, in pounds.*

| Year. | Canada. | Mexico. | South America. | Europe. | Other countries. | Total imports. |
|---|---|---|---|---|---|---|
| 1917 | 11,738,379 | 125,782,759 | 4,556,460 | 8,945,899 | 5,520,323 | 156,543,820 |
| 1918 | 28,225,878 | 162,259,199 | 1,962,124 | 62,510 | 4,705,049 | 197,214,760 |
| 1919 | 10,391,115 | 125,541,614 | 5,504,416 | 89,840 | 286,142 | 141,813,127 |
| 1920 | 8,199,234 | 131,815,278 | 7,085,351 | 38,766,504 | 11,163,160 | 197,029,527 |
| 1921 | 8,127,158 | 106,406,238 | 2,381,365 | 30,224,701 | 1,430,949 | 148,570,411 |
| 1922 | 8,663,236 | 141,216,136 | 3,803,478 | 1,454,384 | 513,335 | 155,650,569 |

The high price of lead shortly before and during the World War made it profitable to export domestic lead. Beginning in March, 1914, the exports soon reached large quantities, but they declined rapidly after the war.

*Refined lead made from domestic ores and exported from the United States, 1914–1922.*

| Year. | Short tons. | Value. | Year. | Short tons. | Value. |
|---|---|---|---|---|---|
| 1914 | 58,722 | $4,501,674 | 1919 | 10,510 | $1,471,256 |
| 1915 | 88,306 | 7,928,518 | 1920 | 2,730 | 462,223 |
| 1916 | 100,500 | 13,494,065 | 1921 | 1,624 | 177,926 |
| 1917 | 53,688 | 9,560,598 | 1922 | 5,823 | 604,605 |
| 1918 | 41,831 | 5,889,381 | | | |

By foreign-lead exports are meant the exports of lead of foreign origin which has been smelted, refined, or manufactured in this country and then shipped abroad.

*Foreign lead exported from the United States, 1917–1922.*

| Year. | Exported from warehouse. | | | Exported in manufactures with benefit of drawback (pounds). |
|---|---|---|---|---|
| | Pigs, bars, and old.[a] | | All other manufactures. | |
| | Pounds. | Value. | | |
| 1917 | 75,304,480 | $6,650,157 | $900 | 15,074,947 |
| 1918 | 118,832,344 | 8,309,798 | 4,347 | 6,852,173 |
| 1919 | 81,951,396 | 4,536,273 | 44 | 3,872,136 |
| 1920 | 34,725,501 | 2,570,535 | 35,146 | 12,350,794 |
| 1921 | 50,000,259 | 2,284,107 | 613 | 18,738,927 |
| 1922 | 64,709,305 | 3,177,360 | 146 | 11,354,076 |

[a] Since July 1, 1915, the Bureau of Foreign and Domestic Commerce has classed all foreign lead smelted or refined in this country and exported as "domestic exports of pigs, bars, etc., produced from foreign ore." These figures include also the re-exports of foreign pigs and bars.

*Domestic and foreign pig lead exported from the United States, 1921–22, by destination*

[Figures in parentheses are not duplicated in the totals.]

| Destination. | Domestic. | | Foreign. | |
|---|---|---|---|---|
| | Short tons. | Value. | Short tons. | Value. |
| **1921.** | | | | |
| Asia | 47 | $4,180 | 4,206 | $343,944 |
| Japan | (28) | (2,105) | (4,200) | (343,456) |
| Australia and Oceania | 39 | 4,258 | | |
| Philippine Islands | (36) | (3,977) | | |
| Canada | 170 | 21,406 | 40 | 4,405 |
| Cuba | 79 | 9,504 | 24 | 4,337 |
| Europe | 979 | 97,013 | 19,368 | 1,816,710 |
| Denmark | | | (112) | (9,865) |
| France | (616) | (57,927) | (224) | (21,066) |
| Germany | (224) | (21,063) | (4,420) | (403,279) |
| Great Britain | (3) | (339) | (13,154) | (1,247,939) |
| Netherlands | (118) | (15,799) | (1,401) | (130,081) |
| Mexico | 105 | 13,669 | 116 | 13,538 |
| South America | 99 | 14,134 | 1,243 | 100,646 |
| Argentina | (26) | (4,000) | (280) | (22,846) |
| Brazil | (3) | (301) | (839) | (68,165) |
| Uruguay | (17) | (1,925) | (112) | (8,624) |
| Panama | 28 | 5,001 | | |
| Other countries | 78 | 8,761 | 3 | 532 |
| | 1,624 | 177,926 | 25,000 | 2,284,107 |
| **1922.** | | | | |
| Asia | 305 | 36,870 | 184 | 17,140 |
| Japan | (246) | (30,315) | (56) | (4,536) |
| Philippine Islands | (38) | (4,143) | (6) | (738) |
| Australia and Oceania | 1 | 110 | | |
| Canada | 337 | 43,559 | 150 | 17,701 |
| Cuba | 84 | 12,079 | 5 | 587 |
| Europe | 3,819 | 379,504 | 28,763 | 2,824,779 |
| Denmark | (112) | (11,200) | (364) | (34,227) |
| France | (1,737) | (175,311) | (10,678) | (1,029,605) |
| Germany | (594) | (56,286) | (6,947) | (675,543) |
| Great Britain | (1,374) | (136,550) | (8,281) | (844,967) |
| Netherlands | (1) | (142) | (1,681) | (161,881) |
| Mexico | 78 | 10,634 | 20 | 1,707 |
| South America | 1,120 | 110,649 | 3,231 | 315,269 |
| Argentina | (537) | (47,143) | (698) | (60,802) |
| Brazil | (456) | (45,027) | (2,286) | (229,882) |
| Uruguay | | | (179) | (16,008) |
| Panama | 1 | 169 | | |
| Other countries | 78 | 11,031 | 2 | 177 |
| | 5,823 | 604,605 | 32,355 | 3,177,360 |

## CONSUMPTION.

*Apparent consumption of refined primary lead in the United States, refinery stocks disregarded, in short tons, 1917–1922.*

| | 1917 | 1918 | 1919 | 1920 | 1921 | 1922 |
|---|---|---|---|---|---|---|
| Supply: | | | | | | |
| Stock in bonded warehouse Jan. 1 | 535 | 2,685 | 472 | 234 | 1,322 | 347 |
| Imports of pigs, bars, and old | 5,793 | 5,240 | 5,107 | 35,719 | 31,301 | 3,551 |
| Production | 610,769 | 640,195 | 482,220 | 529,657 | 448,589 | 532,662 |
| | 617,097 | 648,120 | 487,799 | 565,610 | 481,212 | 536,560 |
| Withdrawn: | | | | | | |
| Exports of foreign lead— | | | | | | |
| From warehouse | 37,652 | 59,416 | 40,976 | 17,363 | 25,000 | 32,355 |
| In manufactures, with benefit of drawback | 7,537 | 3,426 | 1,936 | 6,175 | 9,369 | 5,677 |
| Exports of domestic lead | 53,688 | 41,831 | 10,510 | 2,730 | 1,624 | 5,823 |
| Stock in bonded warehouse Dec. 31 | 2,685 | 472 | 234 | 1,322 | 347 | (a) |
| | 101,562 | 105,145 | 53,656 | 27,590 | 36,340 | 43,855 |
| Apparent consumption | 515,535 | 542,975 | 434,143 | 538,020 | 444,872 | 492,705 |

a Figures not available.

## CUSTOMS DUTIES ON LEAD.

In the following table are shown the tariff imposts on lead in ore and as metal in the tariff acts of 1909, 1913, and 1922. As the duties levied on lead in the tariff of 1913 were ad valorem, in part, the average duty collected over the whole period that the tariff of 1913 was in effect (October 3, 1913, to September 21, 1922) has been calculated, to make comparison easy. The total duty collected on each class has been divided by the total number of pounds of lead in that class to obtain the average duty collected per pound, and this has been inserted in the table in another column for comparison with the specific duties of other tariffs.

*Comparison of tariff imposts on lead in acts of 1909, 1913, and 1922, in cents per pound.*

| | 1909 | 1913 | | 1922 |
|---|---|---|---|---|
| | | Tariff. | Average collected. | |
| | Cents. | | Cents. | Cents. |
| Lead-bearing ore, lead content | 1½ | ¾ cent | ¾ | 1½ |
| Base bullion, lead content | 2⅛ | 25 per cent | 1 | 2⅛ |
| Lead, pigs, bars and old | 2⅛ | 25 per cent | 1 1/16 | 2⅛ |
| Sheets, pipe, shot, etc | 2⅜ | 25 per cent | 2 | 2⅜ |
| Type metal, lead content | 1½ | 15 per cent | ½ | 2⅛ |

## PRICES AND VALUE.

Lead was quoted for immediate delivery in New York at the beginning of 1922 at 4.7 cents a pound in the open market and remained at that figure through the first three months of the year. By early June the price had risen to 5.8 cents, and it stood slightly under this figure until the later part of August. A gradual rise brought the price to 7.25 cents at the end of the year.

The average quoted price for lead for prompt delivery in New York for the year was a little under 5.7 cents a pound, as compared

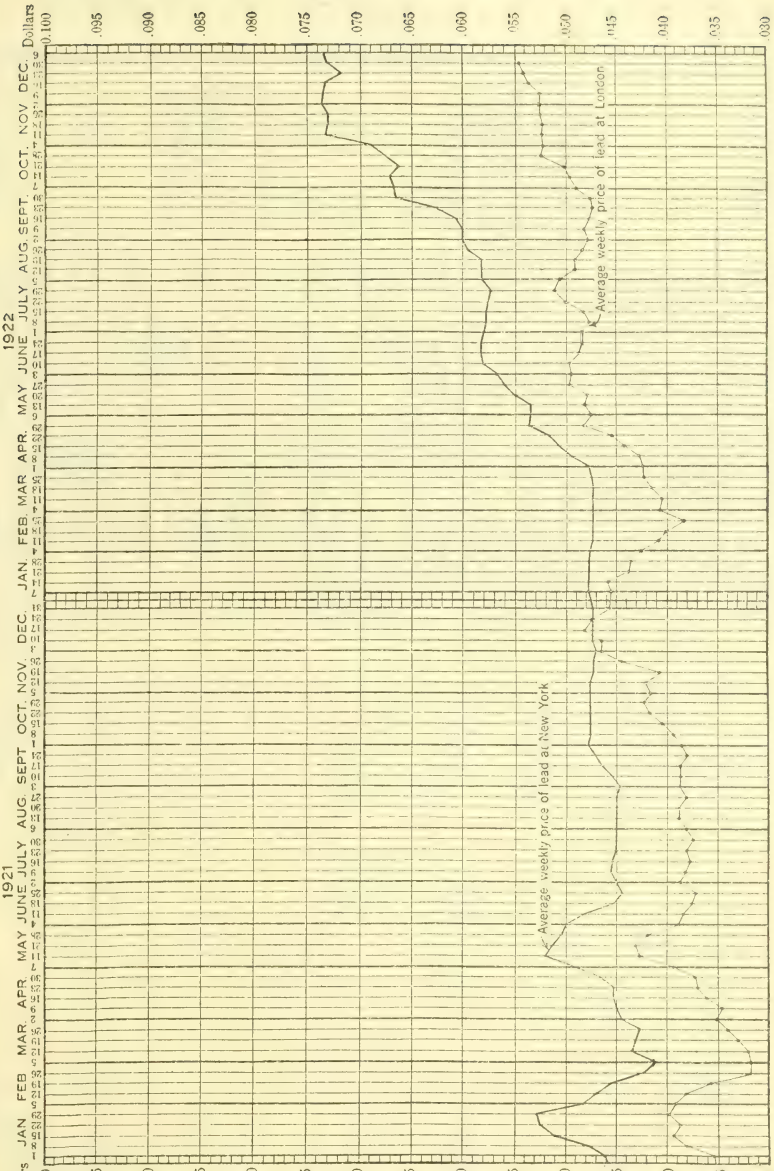


FIGURE 1.—Average weekly quoted price of lead at New York and London, 1921 and 1922, fluctuations in exchange being taken into account.

with 4.7 cents in 1921. The average selling price, figured on the total sales during the year, was 5.5 cents a pound, as compared with 4.5 cents in 1921. The average selling price is used in calculating the value of lead produced from domestic ores in the United States.

*Prices quoted on lead by the American Smelting & Refining Co. in 1922, in cents a pound.*

| | | |
|---|---|---|
| Jan. 2 ..... 4.70 | May 18 ..... 5.50 | Sept. 27 ..... 6.35 |
| Mar. 30 ..... 4.80 | May 29 ..... 5.65 | Oct. 6 ..... 6.50 |
| Apr. 3 ..... 4.90 | June 7 ..... 5.75 | Nov. 1 ..... 6.75 |
| Apr. 7 ..... 5.00 | Aug. 21 ..... 5.90 | Nov. 2 ..... 7.00 |
| Apr. 20 ..... 5.10 | Sept. 14 ..... 6.00 | Nov. 24 ..... 7.10 |
| Apr. 24 ..... 5.25 | Sept. 19 ..... 6.10 | Dec. 19 ..... 7.25 |
| May 16 ..... 5.35 | Sept. 22 ..... 6.25 | Dec. 29 ..... 7.25 |

The London price of lead was very close to the New York price at the beginning of the year, but the difference between them gradually widened until it was nearly 2 cents a pound at the end of the year, in part owing to the tariff of 1922, which imposes a duty of $2\frac{1}{8}$ cents a pound on imported lead. These facts are shown in a striking way by the graphs in Figure 1, which take into account the fluctuations in exchange and show that the London market was more responsive to trade conditions than the New York market.

As stated on page 27, the value of the refined lead produced in the United States from domestic ores in 1922 was $51,562,000 at the average price of refined lead, as compared with $35,840,000 at the average price in 1921, a gain of 44 per cent.

# ZINC.[1]

By C. E. Siebenthal and A. Stoll.

## SUMMARY.

*Zinc produced and consumed in the United States, 1921–22, in short tons.*

| | 1921 | 1922 |
|---|---|---|
| Production of primary zinc: [a] | | |
| From domestic ore | 198,232 | 353,274 |
| From foreign ore | 2,268 | 1,003 |
| | 200,500 | 354,277 |
| Production of secondary zinc: [a] | | |
| Redistilled | 17,573 | 32,988 |
| Remelted | 16,260 | 36,326 |
| | 33,833 | 69,314 |
| | 234,333 | 423,591 |
| Apparent consumption of primary zinc | 203,600 | 373,090 |

[a] "Primary zinc," which is produced directly from ore, is here distinguished from "secondary zinc," which is obtained by refining zinc ashes, skimmings, drosses, and old metals. The statistics of secondary zinc are given on page 40. Wherever in this report the word "zinc" is used without qualification it means primary zinc.

Owing to necessary economies in Government printing it has been deemed advisable to omit the notes explaining the tables in these reports. The reader will find the full notes in the chapter on zinc in Mineral Resources for 1918. For the same reason the period covered by the tables has generally been limited to the years 1917–1922, and some tables have been omitted.

## PRODUCTION.

### PRIMARY ZINC.

*Primary zinc produced in the United States, 1917–1922, in short tons.*

**Apportioned according to source of ore.**

| | 1917 | 1918 | 1919 | 1920 | 1921 | 1922 |
|---|---|---|---|---|---|---|
| Total domestic | 584,597 | 492,405 | 452,272 | 450,045 | 198,232 | 353,274 |
| Foreign: | | | | | | |
| Canada | 6,787 | 8,700 | 4,007 | 1,583 | 521 | 55 |
| Mexico | 40,360 | 14,043 | 8,083 | 8,978 | 1,614 | 948 |
| South America | ..... | 886 | 751 | 536 | ..... | ..... |
| Europe | 11,689 | 113 | ..... | ..... | ..... | ..... |
| Australia | 26,140 | 1,780 | 630 | 2,235 | 133 | ..... |
| Total foreign | 84,976 | 25,522 | 13,471 | 13,332 | 2,268 | 1,003 |
| Total primary | 669,573 | 517,927 | 465,743 | 463,377 | 200,500 | 354,277 |

[1] Chapters on zinc that were more than ordinarily detailed were issued in Mineral Resources for 1908, dealing largely with metallurgy; for 1915, dealing with the zinc deposits of the United States and foreign countries; and for 1918, dealing with the zinc industry in relation to the World War.

*Primary zinc produced in the United States, 1917–1922, in short tons*—Continued.

**Apportioned according to locality at which reduced.**

| | 1917 | 1918 | 1919 | 1920 | 1921 | 1922 |
|---|---|---|---|---|---|---|
| Arkansas | 25,660 | 26,753 | 31,437 | 31,481 | 15,278 | 13,627 |
| Illinois | 172,489 | 141,844 | 118,458 | 109,056 | 48,865 | 76,266 |
| Kansas | 76,048 | 29,149 | 43,942 | 41,044 | 16,573 | 24,167 |
| Oklahoma | 204,394 | 139,066 | 121,988 | 110,500 | 41,244 | 74,537 |
| Pennsylvania | 86,995 | 77,342 | 67,521 | 74,234 | 36,378 | 57,319 |
| Other States | 103,987 | 103,773 | 82,397 | 97,062 | 42,162 | 108,361 |
| | 669,573 | 517,927 | 465,743 | 463,377 | 200,500 | 354,277 |

## DISTILLED AND ELECTROLYTIC ZINC.

Selected secondary zinc materials, such as zinc ashes and scrap, carefully redistilled, yield zinc of all grades, which enters the market for practically all purposes. Considerable secondary material is mixed with ore and used by some regular ore smelters. The quantity of metal so derived can be calculated by the smelters and thus eliminated from the output of primary zinc, but it is practically impossible to segregate the redistilled secondary zinc by grades or in smelter stocks. Hence the smelter stocks as given contain some secondary zinc, and the statistics of production of zinc by grades as given in the table below likewise include secondary zinc. The quantity of secondary zinc included in the graded zinc is given in the first part of the table, which gives the source of the graded zinc by the methods of reduction.

*Distilled and electrolytic zinc, primary and secondary, produced in the United States, 1917–1922, in short tons.*

**Apportioned according to method of reduction.**

| | 1917 | 1918 | 1919 | 1920 | 1921 | 1922 |
|---|---|---|---|---|---|---|
| Electrolytic | [a] 25,209 | [a] 38,916 | 27,056 | 51,626 | 11,559 | 55,369 |
| Distilled primary | 644,364 | 479,011 | 438,687 | 411,751 | 188,941 | 298,908 |
| Redistilled secondary zinc [b] | 16,835 | 9,918 | 19,748 | 21,371 | 17,573 | 32,988 |
| | 686,408 | 527,845 | 485,491 | 484,748 | 218,073 | 387,265 |

**Apportioned according to grade.**

| | | | | | | |
|---|---|---|---|---|---|---|
| Grade A (high grade) | 97,707 | 129,344 | 45,377 | 80,713 | 24,084 | 67,459 |
| Grade B (intermediate) | 69,189 | 68,987 | 39,173 | 33,893 | 4,996 | 36,402 |
| Grade C (select and brass special) | 148,749 | 98,584 | 140,917 | 59,811 | 47,814 | 49,980 |
| Grade D (prime western) | 370,763 | 230,930 | 260,024 | 310,331 | 141,179 | 233,424 |
| | 686,408 | 527,845 | 485,491 | 484,748 | 218,073 | 387,265 |

[a] Prime western zinc refined by electrolysis in addition: In 1917, 1,701 tons; in 1918, 753 tons.
[b] For total production of secondary zinc, see p. 40.

## ROLLED ZINC.

The table below includes the exports as shown by the records of the Bureau of Foreign and Domestic Commerce. If the figures showing the exports are deducted from those showing the production plus the imports, the result will approximate the quantity available for domestic consumption.

*Zinc rolled in the United States, 1921 and 1922.*

| | 1921 | 1922 |
|---|---|---|
| Sheet zinc not over one-tenth inch thick: | | |
| Quantity.....pounds.. | 28,580,904 | 50,203,438 |
| Value | $2,844,406 | $4,044,688 |
| Average price per pound | $0.100 | $0.081 |
| Boiler plate and sheets over one-tenth inch thick: | | |
| Quantity.....pounds.. | 2,545,755 | 2,229,877 |
| Value | $192,987 | $155,074 |
| Average price per pound | $0.076 | $0.070 |
| Strip and ribbon zinc: | | |
| Quantity.....pounds.. | 29,673,527 | 54,585,375 |
| Value | $2,902,815 | $4,316,347 |
| Average price per pound | $0.098 | $0.080 |
| Total rolled zinc: | | |
| Quantity.....pounds.. | 60,800,186 | 107,018,690 |
| Value | $5,940,208 | $8,546,109 |
| Average price per pound | $0.098 | $0.080 |
| Sheet zinc imported and entered for consumption: | | |
| Quantity.....pounds.. | 13,375,245 | 831,141 |
| Value | $496,445 | $59,037 |
| Declared value per pound at foreign mills | $0.037 | $0.071 |
| Rolled zinc exported: | | |
| Quantity.....pounds.. | 3,631,647 | 6,433,089 |
| Value | $425,618 | $574,491 |
| Average price per pound | $0.117 | $0.089 |
| Available for consumption.....pounds.. | 70,543,784 | 101,416,742 |

The following table shows the difference, or "spread," between the average price per pound of grades B and C zinc, which are those used in rolled zinc, and the average price per pound of zinc sheets. During the later part of the World War the great demand for zinc sheets for packing munitions sent the price to a high figure, with a resulting wide difference between the price of sheets and of the metal. The decline in the demand for sheets after the war caused a drop in prices, and the difference was narrowed. In the early part of 1921 sheets were selling at about the old price, but there was a great fall in the price of slab metal, so that the difference was nearly equal to that of war times. This condition, aided by the depressed rates of foreign exchange, led to the importation of large quantities of foreign sheets, principally from Belgium and Germany. In 1922 the average price of sheet zinc was nearly 2 cents a pound lower than in the preceding year and the average price of slab zinc was higher, so that the spread between them was greatly reduced. The weekly fluctuation in the quoted price of zinc sheets is shown by the curve in Figure 3.

*Difference between prices of slab zinc and zinc sheets, 1917–1922, in cents per pound.*

| | 1917 | 1918 | 1919 | 1920 | 1921 | 1922 |
|---|---|---|---|---|---|---|
| Average price of sheets | 17.5 | 15.0 | 10.5 | 11.5 | 9.8 | 8.0 |
| Average price of grades B and C zinc | 11.1 | 9.4 | 7.5 | 8.3 | 5.0 | 5.8 |
| Difference | 6.4 | 5.6 | 3.0 | 3.2 | 4.8 | 2.2 |

## ZINC DUST.

*Zinc dust produced in the United States, 1917–1922.*

| Year. | Prepared "blue powder." | | | Zinc dust "atomized." | | |
|---|---|---|---|---|---|---|
| | Short tons. | Value.[a] | Average price per pound. | Short tons. | Value.[a] | Average price per pound. |
| 1917 | 3,989 | $1,322,196 | $0.166 | 1,924 | $642,782 | $0.167 |
| 1918 | 4,016 | 877,171 | .109 | 2,979 | 773,746 | .130 |
| 1919 | [b] 4,083 | 801,366 | .098 | [b] 2,515 | 524,694 | .104 |
| 1920 | [b] 9,066 | 2,009,117 | .111 | [b] 2,273 | 512,833 | .113 |
| 1921 | [b] 2,006 | 333,390 | .083 | [b] 789 | 120,231 | .076 |
| 1922 | [b] 3,394 | 531,225 | .078 | [b] 3,634 | 539,920 | .074 |

[a] Value is calculated from the total value of material sold during year.
[b] Statistics of the quantity of secondary zinc recovered as zinc dust are given in the table below headed "Secondary zinc."

The average price of zinc dust, "blue powder," as calculated from sales during the year, was 7.8 cents a pound, and "atomized" zinc dust brought 7.4 cents a pound. "Blue powder" brought a higher average price than "atomized" dust because much of it was sold in the far West, where higher prices prevailed. The weekly fluctuation in the quoted price of zinc dust is shown in Figure 3 (p. 52).

## ZINC PIGMENTS.

Zinc forms the base, either in whole or in part, of four white pigments—zinc oxide, leaded zinc oxide, zinc-lead oxide, and lithopone. Details of the production of zinc pigments and of market conditions are given in the chapter on lead and zinc pigments and salts.

The zinc content of the pigments made in the United States from ore, both domestic and foreign, for the period 1917–1922 is given in the table below. Statistics of the secondary zinc recovered in the form of pigments are given under the next heading.

*Primary zinc content of zinc pigments made in the United States, 1917–1922, in short tons.*

| | | | |
|---|---|---|---|
| 1917 | 97,573 | 1920 | 110,695 |
| 1918 | 102,778 | 1921 | 53,480 |
| 1919 | 96,817 | 1922 | 93,112 |

## SECONDARY ZINC.[2]

*Secondary zinc recovered in the United States, 1920–1922, in short tons.*

| | 1920 | 1921 | 1922 |
|---|---|---|---|
| Secondary zinc, redistilled | 21,371 | 17,573 | 32,988 |
| Secondary zinc, remelted | 21,479 | 16,260 | 36,326 |
| Recovered zinc in alloys, excluding old brass remelted | 7,650 | 5,840 | 10,250 |
| Recovered zinc in remelted brass | 65,000 | 38,627 | 60,280 |
| Secondary zinc recovered as metal | 115,500 | 78,300 | 139,844 |
| Secondary zinc recovered in zinc dust | 1,061 | 755 | 3,405 |
| Secondary zinc recovered in pigments | 12,870 | 4,024 | 8,609 |
| Secondary zinc recovered in zinc salts | 9,479 | 10,225 | 9,016 |
| Total secondary zinc | 139,000 | 93,000 | 161,000 |

[2] See page 37 for definition of secondary zinc.

## BY-PRODUCT SULPHURIC ACID.

An important by-product of zinc-smelting operations is the sulphuric acid made from the sulphur gases evolved in roasting the zinc sulphide ores preparatory to their distillation or conversion to zinc oxide or to zinc salts. Sulphur gases from zinc ores were first thus utilized by Matthiessen & Hegeler, at La Salle, Ill., in 1882, but now there are numerous acid plants using these gases. These acid plants may be located at zinc smelters and zinc-oxide plants, at roasting and magnetic separating plants, at the mines, or nearer the acid markets, the roasted concentrates being shipped to the smelters or to other zinc plants. Figures of output of this by-product acid for the period 1914–1920 were given in the chapter on zinc in Mineral Resources, 1920. The following table is made up from the reports of the biennial census of manufactures by the Bureau of the Census, Department of Commerce. The quantity and value of acid made from copper ores is included for comparison.

*By-product sulphuric acid produced in the United States, 1919 and 1921.*

| | 1919 | 1921 |
|---|---|---|
| *Acid made from zinc ores.* | | |
| Number of establishments | 14 | 14 |
| Acid reported as 50°–60° Baumé: | | |
| Total.....short tons | 397,198 | 233,136 |
| Consumed at works.....do | 7,732 | 37,242 |
| Sold.....do | 389,466 | 195,894 |
| Value of acid sold: | | |
| Total | $4,698,035 | $2,155,314 |
| Average | $12.06 | $11.00 |
| Acid reported as 66° Baumé and stronger: | | |
| Total.....short tons | 79,148 | 72,038 |
| Consumed at works.....do | 5,287 | 7,439 |
| Sold.....do | 73,861 | 64,599 |
| Value of acid sold: | | |
| Total | $1,467,301 | $1,248,654 |
| Average | $19.87 | $19.33 |
| Total acid sold, equivalent in 60° Baumé: | | |
| Quantity.....short tons | 502,324 | 286,826 |
| Value | $6,165,336 | $3,403,968 |
| *Acid made from copper ores.* | | |
| Number of establishments | 6 | 5 |
| Total acid sold, equivalent in 60° Baumé: | | |
| Quantity.....short tons | 364,581 | 285,444 |
| Value | $2,084,087 | $2,431,025 |

## MINE PRODUCTION.

The preceding tables give the quantity of zinc recovered either as metal by smelting and by electrolytic reduction, or in zinc dust, or as zinc in pigments. The following table shows the origin of the domestic zinc that is recovered by metallurgic operations. The origin of the zinc by States is obtained more accurately from the reports of mines, because smelters necessarily treat mixtures of ores, sometimes long after they have been received, so that the actual output of metallic zinc may not correspond at all closely to the product of the mines for the same year. The data for the tables of mine production are taken from the reports on gold, silver, copper, lead, and zinc in the different States.

*Mine production of zinc in the United States, 1917–1922, in short tons.*

| State. | 1917 | 1918 | 1919 | 1920 | 1921 | 1922 |
|---|---|---|---|---|---|---|
| Arizona | 10,447 | 1,135 | 859 | 729 | ..... | 105 |
| Arkansas | 6,691 | 961 | 189 | 329 | 15 | 184 |
| California | 5,436 | 2,781 | 236 | 583 | 529 | 1,506 |
| Colorado | 60,148 | 44,367 | 18,610 | 24,395 | 1,180 | 11,629 |
| Idaho | 39,927 | 22,581 | 7,997 | 13,966 | 17 | 2,055 |
| Illinois | 4,267 | 3,792 | 6,788 | 4,720 | 2,426 | 3,124 |
| Iowa | 18 | ..... | ..... | ..... | ..... | ..... |
| Kansas | 20,249 | 30,197 | 47,636 | 61,079 | 36,994 | 56,225 |
| Kentucky | 731 | 315 | 36 | 9 | 220 | 142 |
| Missouri | 132,918 | 55,892 | 31,540 | 24,309 | 10,845 | 16,171 |
| Montana | 93,130 | 104,479 | 84,382 | 92,169 | 11,638 | 39,535 |
| Nevada | 11,144 | 8,892 | 4,502 | 5,349 | 35 | 1,309 |
| New Hampshire | 45 | 14 | ..... | ..... | ..... | ..... |
| New Jersey | 120,846 | 98,470 | 92,912 | 77,371 | 50,447 | 73,617 |
| New Mexico | 15,100 | 12,625 | 3,797 | 5,607 | 114 | 2,248 |
| New York | 5,192 | 6,776 | 5,120 | 5,604 | 1,372 | 4,816 |
| Oklahoma | 85,835 | 161,401 | 178,410 | 219,727 | 121,372 | 209,682 |
| Tennessee | 28,498 | 21,071 | 23,247 | 19,217 | 9,092 | 13,268 |
| Texas | 11 | ..... | ..... | ..... | ..... | ..... |
| Utah | 10,643 | 9,200 | 2,216 | 4,079 | 35 | 2,360 |
| Virginia | 1,703 | 931 | ..... | ..... | ..... | ..... |
| Washington | 598 | 19 | ..... | 219 | 226 | 614 |
| Wisconsin | 59,742 | 50,014 | 40,765 | 27,285 | 9,390 | 10,962 |
| | 713,539 | 632,243 | 549,242 | 586,384 | 256,746 | 472,702 |

## ZINC-REDUCTION PLANTS.

*Zinc-smelting plants operating in 1922.*

| Operating company. | Location of plant. | Retorts. |
|---|---|---|
| ARKANSAS. | | |
| Athletic Mining & Smelting Co. | Fort Smith | 2,496 |
| Fort Smith Spelter Co. | do. | 2,460 |
| ILLINOIS. | | |
| American Zinc Co. of Illinois | Hillsboro | 4,864 |
| Do. | East St. Louis | 5,620 |
| Eagle-Picher Lead Co. | Hillsboro | 3,200 |
| Hegeler Zinc Co. | Danville | 5,400 |
| Illinois Zinc Co. | Peru | 7,520 |
| Matthiessen & Hegeler Zinc Co. | La Salle | 6,152 |
| Mineral Point Zinc Co. | Depue | 6,068 |
| Missouri Zinc Co. | Beckemeyer | 500 |
| INDIANA. | | |
| Grasselli Chemical Co. | Terre Haute | 4,200 |
| KANSAS. | | |
| Edgar Zinc Co. | Cherryvale | 5,040 |
| OKLAHOMA. | | |
| Bartlesville Zinc Co. (including Langdon-Starr plant) | Bartlesville | 8,640 |
| Blackwell Zinc Co., Inc. | Blackwell | 5,400 |
| Eagle-Picher Lead Co. | Henryetta | 4,800 |
| National Zinc Co. | Bartlesville | 4,200 |
| Quapaw Spelter Co. | Quapaw | 3,600 |
| Tulsa Fuel & Manufacturing Co. | Collinsville | 6,272 |
| United States Zinc Co. | Kuss | 3,240 |
| Do. | Henryetta | 2,448 |
| Do. | Sand Springs | 6,700 |
| PENNSYLVANIA. | | |
| American Steel & Wire Co. | Donora | 5,512 |
| American Zinc & Chemical Co. | Langeloth | 7,200 |
| New Jersey Zinc Co. of Pennsylvania | Palmerton | 7,200 |
| WEST VIRGINIA. | | |
| Grasselli Chemical Co. | Clarksburg | 5,760 |
| Do. | Meadowbrook | 8,640 |
| United Zinc Smelting Corporation | Mausdale | 2,500 |
| | | 142,800 |

The number of retorts at zinc smelters at the end of 1922 was 142,820 at 27 plants that had operated sometime during the year. The number of retorts in operation at the end of the year was 81,030 at 26 plants, compared with 42,200 in operation at 19 plants at the end of 1921. The following plants made no production in 1922:

Arkansas Zinc & Smelting Corporation, Van Buren, Ark.
Bartlesville Zinc Co., Lanyon-Starr plant, Bartlesville, Okla.
Sandoval Zinc Co., Sandoval, Ill.
United States Zinc Co., Pueblo, Colo.
Victory Metal Co., Henryetta, Okla.
Weir Smelting Co., Caney, Kans.

In addition to the foregoing regular retort smelters the Anaconda Copper Mining Co. operated its electrolytic zinc plant at Great Falls, Mont.

The following plants treating secondary materials in large graphite retorts were in operation during the year:

General Smelting Co., Philadelphia, Pa.
Tottenville Copper Co., Tottenville, N. Y.
Trenton Smelting & Refining Co., Trenton, N. J.
Wheeling Steel Corporation, Wheeling, W. Va.

The smelter of the Arkansas Zinc & Smelting Corporation at Van Buren, Ark., was purchased by William Lanyon and will be operated as the Falcon Zinc Co.

The United Zinc Smelting Corporation added a third block of retorts to its smelter at Moundsville, W. Va.

The United States Zinc Co. is building a 5-block plant at Amarillo, Tex., to be fired with natural gas. This plant will have 4,000 retorts and will start with 2,400 retorts in May and be completed by July, 1923. It will be equipped with three modified Ropp roasters and will have a capacity of about 4,000 tons of concentrates a month.

## ELECTROLYTIC ZINC PLANTS.

Apparently the doubt prevalent five or six years ago whether electrolytic reduction of zinc ores could compete commercially with retort smelting no longer exists, for electrolytic plants having a reduction capacity approximately equal to one-fifth of the world's normal output of zinc will be in operation in the near future. The following table shows the reported present and prospective capacity of the principal electrolytic zinc plants of the world.

*Annual capacity of principal electrolytic zinc plants of the world, in short tons.*

| | 1922 | Additional in near future. |
|---|---|---|
| Anaconda Copper Mining Co., Great Falls, Mont | 75,000 | ..... |
| Bunker Hill & Sullivan Mining Co., Kellogg, Idaho | ..... | 15,000 |
| Consolidated Smelting & Refining Co., Trail, British Columbia | 46,000 | ..... |
| Electrolytic Zinc Co. of Australasia (Ltd.), Risdon, Tasmania | 25,000 | 25,000 |
| Plants in England, Italy, Rhodesia (Broken Hill), and Japan | 10,000 | 5,000 |
| Smaller plants in the United States | 10,000 | ..... |
| | 166,000 | 45,000 |

## TRADE CONDITIONS.

### WORLD'S PRODUCTION.

In the following table, prepared by W. I. Whiteside, of the United States Geological Survey, the figures in black-faced type are taken from the official statistics of the countries named; those in ordinary type, for the years prior to 1922, and for Norway and Sweden in 1922 are taken from the yearbook of the American Bureau of Metal Statistics, an association of the copper producers, the lead producers, and the principal zinc producers of this country. Figures in ordinary type for 1922 and for China are taken from the preliminary figures of Rudolf Wolff & Co., of London, as are also the figures for Austria and France in 1921. The official statistics will be substituted in this record as fast as they are made available.

There is always a possibility of duplication in figures showing European production, for some countries send crude zinc of poor quality to other countries for refining. Furthermore, secondary zinc is included in the figures showing the foreign production, so that to put the United States on an equal footing in the statistics it would be necessary to include in the statement of its production figures for the domestic output of secondary zinc.

*World's smelter production of zinc, 1913 and 1917-1922, in metric tons, by countries where smelted.*

| Country. | 1913 | 1917 | 1918 | 1919 | 1920 | 1921 | 1922 |
|---|---|---|---|---|---|---|---|
| Australia: | | | | | | | |
| New South Wales | 4,187 | 4,769 | 5,712 | 3,625 | 3,909 | ..... | ..... |
| Tasmania | ..... | 49 | 3,883 | 3,727 | 5,911 | 1,136 | 24,105 |
| Austria | 19,508 | 12,413 | 12,000 | (*a*) | (*a*) | 240 | 250 |
| Belgium | 204,220 | 10,290 | 9,245 | 19,860 | 84,260 | 66,150 | 113,137 |
| Canada | ..... | 9,058 | 11,139 | 11,182 | 16,798 | 24,035 | 25,533 |
| China | (*b*) | (*b*) | (*b*) | (*b*) | 180 | 1,290 | 2,000 |
| France | 67,890 | 22,929 | 18,347 | 10,800 | 19,655 | 24,358 | 40,450 |
| Germany: | | | | | | | |
| Upper Silesia | 169,439 | 128,832 | 122,961 | 74,023 | 81,482 | 93,500 | 105,507 |
| Other Germany | 109,420 | 57,648 | 62,212 | 23,381 | 15,083 | | |
| Great Britain | 66,243 | 51,918 | 39,001 | 38,227 | 25,000 | 5,910 | 12,708 |
| Italy | ..... | 367 | 1,188 | 1,282 | 1,177 | 527 | 3,060 |
| Japan | 900 | 54,718 | 39,915 | 19,816 | 15,745 | 10,374 | 7,000 |
| Jugoslavia and Czechoslovakia | (*c*) | (*c*) | (*c*) | 4,010 | 6,000 | 6,000 | 4,400 |
| Netherlands | 24,323 | 4,059 | 681 | ..... | 2,031 | 6,405 | 13,008 |
| Norway | 9,287 | 1,752 | 1,855 | 3,386 | 1,837 | 2,000 | 1,850 |
| Poland | (*d*) | (*d*) | (*d*) | 4,652 | 5,361 | 7,026 | 3,561 |
| Russia | 10,500 | 8,334 | 4,893 | (*e*) | (*e*) | (*e*) | (*e*) |
| Siberia | ..... | 569 | (*b*) | (*b*) | (*b*) | (*b*) | (*b*) |
| Spain | 6,603 | 10,155 | 15,900 | 16,314 | 9,647 | 6,738 | 6,298 |
| Sweden | 2,115 | 7,979 | 4,098 | 2,321 | 5,759 | 3,510 | 1,900 |
| United States | 314,498 | 607,423 | 469,853 | 422,513 | 420,366 | 181,890 | 321,393 |
| Known output | 1,008,500 | 993,300 | 823,000 | 659,000 | 720,000 | 441,000 | 686,000 |

*a* See Jugoslavia and Czechoslovakia.
*b* Statistics not available.
*c* See Austria.
*d* Included in Russia.
*e* See Poland.

The following table shows the output of zinc ore by different countries in the years 1918–1921, inclusive. Official reports for 1922 were almost altogether lacking at the time the table was prepared. The zinc content is estimated where possible, but many official reports give no information on which such an estimate could be based.

*World's mine production of zinc ore and concentrates, with estimated zinc content, 1918–1921, in metric tons.*

| Country. | 1918 | | 1919 | | 1920 | | 1921 | |
|---|---|---|---|---|---|---|---|---|
| | Ore. | Zinc content. | Ore. | Zinc content. | Ore. | Zinc content. | Ore. | Zinc content. |
| North America: | | | | | | | | |
| Canada | 109,950 | 28,588 | 122,955 | 27,197 | 226,011 | 41,292 | (a) | (a) |
| Mexico (imports into United States) | 48,396 | 16,716 | 30,339 | 10,183 | 43,048 | 13,585 | 5,488 | 1,948 |
| United States (recoverable zinc) | (a) | 573,558 | (a) | 498,261 | (a) | 531,956 | (a) | 232,915 |
| South America: | | | | | | | | |
| Bolivia | | | 1,902 | (a) | 1,206 | (a) | | |
| Europe: | | | | | | | | |
| Austria (lead-zinc ore) | (a) | (a) | 79,113 | 240 | 78,351 | 476 | 76,259 | 108 |
| France (lead-zinc ore) | 25,087 | 6,603 | 19,949 | b 5,200 | 43,000 | b 11,000 | (a) | (a) |
| Germany— | | | | | | | | |
| Upper Silesia | 342,209 | 132,428 | 218,487 | 82,704 | 243,308 | 92,257 | 254,387 | b 97,000 |
| Other Germany | 102,858 | 46,463 | 66,538 | 30,381 | 48,147 | 21,733 | (a) | (a) |
| Greece— | | | | | | | | |
| Zinc ore | 4,342 | (a) | 3,334 | (a) | 2,591 | (a) | 1,920 | (a) |
| Zinc-lead ore | | | 2,493 | (a) | 2,636 | (a) | 858 | (a) |
| Italy— | | | | | | | | |
| Zinc ore | 67,116 | 29,471 | 85,778 | 35,160 | 95,985 | b 41,000 | 69,000 | b 29,000 |
| Zinc-lead ore | 800 | 48 | 3,915 | 560 | 570 | b 60 | 840 | b 80 |
| Norway | 268 | (a) | 337 | (a) | 148 | (a) | 7 | (a) |
| Russia— | | | | | | | | |
| Poland | (a) | (a) | 67,645 | (a) | 64,354 | (a) | 37,000 | (a) |
| Caucasus | (a) | (a) | (a) | (a) | (a) | (a) | 3,767 | (a) |
| Spain | 109,030 | 31,121 | 103,608 | 29,902 | 94,095 | 28,250 | 48,357 | 17,446 |
| Sweden | 48,507 | 16,960 | 49,451 | 17,446 | 47,674 | 16,609 | 29,426 | 11,025 |
| United Kingdom | 9,170 | 3,297 | 7,044 | 2,475 | 5,145 | 1,682 | 827 | 297 |
| Asia: | | | | | | | | |
| China | 166 | (a) | 2 | (a) | 9,116 | (a) | 11,928 | (a) |
| Chosen | 1,293 | (a) | 3,212 | (a) | 3,483 | (a) | (a) | (a) |
| Indo-China | 28,650 | (a) | 15,934 | (a) | 7,198 | (a) | 11,035 | (a) |
| Japan | 50,369 | (a) | 495,705 | (a) | 702,985 | (a) | 24,707 | (a) |
| Africa: | | | | | | | | |
| Algeria | 17,940 | 7,890 | 13,293 | 5,583 | 26,562 | 11,156 | 14,550 | 6,693 |
| Tunis | 6,022 | (a) | 40,253 | (a) | 12,575 | (a) | 4,544 | (a) |
| Union of South Africa | | | | | 2,131 | (a) | 1,161 | (a) |
| Australia: | | | | | | | | |
| New South Wales | 88,416 | b 43,000 | 73,454 | b 35,000 | 72,183 | b 35,000 | 80,973 | b 39,000 |

a Not available. b Estimated.

## IMPORTS AND EXPORTS.

The following tables of imports and exports of zinc and of zinc remaining in warehouses have been compiled from the publications and records of the Bureau of Foreign and Domestic Commerce of the Department of Commerce by J. A. Dorsey, of the United States Geological Survey.

*Zinc remaining in warehouse in the United States, Dec. 31, 1917–1922.*

| Year. | Ore and calamine. | | | Blocks, pigs, and old. | | Zinc dust. | |
|---|---|---|---|---|---|---|---|
| | Short tons. | Zinc content (pounds). | Value. | Pounds. | Value. | Pounds. | Value. |
| 1917 | 96,560 | 53,997,636 | $1,177,680 | 63,545 | $3,949 | 64,812 | $5,710 |
| 1918 | (a) | 53,766,247 | 1,089,560 | | | | |
| 1919 | (a) | 37,696,007 | 674,384 | | | | |
| 1920 | (a) | 51,299,109 | 996,386 | | | | |
| 1921 | (a) | 28,583,018 | 647,654 | 262,221 | 10,911 | | |
| 1922 | (a) | | | 160,976 | 6,396 | | |

a Figures not available.

*Zinc imported and entered for consumption in the United States, 1917–1922.*

| Year. | Blocks or pigs. | | Sheets. | | Old. | | Zinc dust. | | Value of manufactures. | Total value. |
|---|---|---|---|---|---|---|---|---|---|---|
| | Short tons. | Value. | Short tons. | Value. | Short tons. | Value. | Short tons. | Value. | | |
| 1917 | 18 | $2,279 | 73 | $16,570 | 259 | $25,974 | 233 | $48,604 | $250 | $93,677 |
| 1918 | 11 | 2,897 | ..... | 29 | 24 | 2,056 | 16 | 3,552 | 331 | 8,865 |
| 1919 | 32 | 2,284 | 1 | 249 | 37 | 2,216 | 52 | 5,753 | 1,258 | 11,760 |
| 1920 | ..... | 17 | 4 | 614 | 14 | 1,065 | 17 | 6,207 | 1,746 | 9,649 |
| 1921 | 6,598 | 559,870 | 6,688 | 496,445 | 6 | 341 | 42 | 1,121 | 8,290 | 1,066,067 |
| 1922 | 40 | 3,327 | 416 | 59,037 | 46 | 2,403 | 79 | 5,614 | 9,517 | 79,898 |

*General imports of old brass fit only for remanufacture, 1917–1922.*

[Average composition about one-third zinc and two-thirds copper.]

| Year. | Short tons. | Value. | Year. | Short tons. | Value. |
|---|---|---|---|---|---|
| 1917 | 27,580 | $9,931,721 | 1920 | 22,355 | $5,174,885 |
| 1918 | 6,115 | 1,774,002 | 1921 | 20,449 | 2,373,082 |
| 1919 | 7,938 | 2,157,948 | 1922 | 71,962 | 10,985,308 |

No American zinc was returned from abroad in 1922. The quantities so returned in the period September, 1920, to March, 1921, are given by months in the chapter on zinc in Mineral Resources, 1921. The tariff of 1922 has a paragraph on the return of United States products, which provides that to be admitted free of duty they must be imported by or for the account of the person who exported them from the United States.

*General imports of zinc ore into the United States, 1904–1922, in short tons.*

| Year. | Canada. | | Mexico. | | Other countries. | | Total. | |
|---|---|---|---|---|---|---|---|---|
| | Ore. | Zinc content. | Ore. | Zinc content. | Ore. | Zinc content. | Ore. | Zinc content. |
| 1904 | ..... | ..... | 2,264 | ..... | ..... | ..... | 2,264 | ..... |
| 1905 | 4,063 | ..... | 18,074 | ..... | ..... | ..... | 22,137 | ..... |
| 1906 | 423 | ..... | 54,991 | ..... | ..... | ..... | 55,414 | ..... |
| 1907 | 1,112 | ..... | 102,005 | ..... | ..... | ..... | 103,117 | ..... |
| 1908 | 7,406 | ..... | 46,351 | ..... | ..... | ..... | 53,757 | ..... |
| 1909 | 10,024 | ..... | 104,826 | ..... | ..... | ..... | 114,850 | ..... |
| 1910 | 4,749 | 1,922 | 67,877 | 23,517 | ..... | ..... | 72,626 | 25,439 |
| 1911 | 2,359 | 947 | 36,757 | 14,986 | ..... | ..... | 39,116 | 15,933 |
| 1912 | 8,015 | 3,661 | 35,925 | 13,606 | ..... | ..... | 43,940 | 17,267 |
| 1913 | 8,899 | 3,498 | 17,476 | 6,160 | 5,041 | 3,839 | 31,416 | 13,497 |
| 1914 | 11,250 | 4,467 | 20,705 | 7,663 | 7 | 2 | 31,962 | 12,132 |
| 1915 | 11,992 | 4,710 | 57,699 | 17,804 | 89,161 | 35,155 | 158,852 | 57,669 |
| 1916 | 21,908 | 8,790 | 161,271 | 51,028 | 202,785 | 88,329 | 385,964 | 148,147 |
| 1917 | 16,559 | 5,155 | 145,358 | 45,697 | 49,678 | 21,622 | 211,595 | 72,474 |
| 1918 | 14,987 | 5,173 | 53,348 | 18,426 | 2,567 | 1,210 | 70,902 | 24,809 |
| 1919 | 10,656 | 3,878 | 33,443 | 11,225 | 4,550 | 1,906 | 48,649 | 17,009 |
| 1920 | 4,731 | 1,794 | 47,453 | 14,975 | 13,589 | 5,718 | 65,773 | 22,487 |
| 1921 | 1,471 | 554 | 6,050 | 2,147 | 18 | 4 | 7,539 | 2,705 |
| 1922 | (a) | 235 | (a) | 1,665 | (a) | 29 | (a) | 1,929 |

a Gross weight not recorded.

The sources of the zinc ore imported from "Other countries" in 1915–1918 are given in the chapter on zinc in Mineral Resources, 1918, Part I, page 1066, and of that imported in 1919–1920, in the chapter in Mineral Resources, 1920, Part I, page 232.

*Domestic zinc ore and domestic manufactures of zinc exported from the United States, 1917–1922.*

| Year. | Zinc ore. | | Pigs or slabs. | | Plates and sheets. | | Zinc dross. | | All other manufactures.[a] | Total value. |
|---|---|---|---|---|---|---|---|---|---|---|
| | Short tons. | Value. | Short tons. | Value. | Short tons. | Value. | Short tons. | Value. | | |
| 1917 | 1,320 | $63,043 | 137,282 | $32,605,767 | 16,514 | $5,730,792 | 13,302 | $2,126,909 | $570,352 | $41,096,863 |
| 1918 | 62 | 2,480 | 66,369 | 12,469,622 | 13,875 | 4,566,756 | 15,816 | 2,238,913 | 722,671 | 20,000,442 |
| 1919 | ..... | ..... | 109,746 | 17,524 153 | 19,762 | 5,212,002 | 5,123 | 739,295 | 538,133 | 24,013,583 |
| 1920 | ..... | ..... | 74,046 | 12,495,144 | 11,852 | 2,832,993 | 2,445 | 316,637 | 1,057,676 | 16,702,450 |
| 1921 | ..... | ..... | 1,753 | 204,984 | 1,816 | 425,618 | 510 | 45,340 | 391,996 | 1,067,938 |
| 1922 | 1,695 | 33,592 | 26,815 | 2,994,625 | 3,217 | 574,491 | 8,412 | 662,080 | 122,087 | 4,386,875 |

[a] Not including brass.

*Domestic brass and brass manufactures exported from the United States, 1917–1922.*

[Zinc content approximately 30 per cent by weight.]

| Year. | Bars, plates, and sheets. | | Scrap and old. | | Articles made from brass. | Total value. |
|---|---|---|---|---|---|---|
| | Short tons. | Value. | Short tons. | Value. | | |
| 1917 | 164,173 | $101,521,426 | 4,149 | $1,758,384 | $136,611,299 | $239,891,109 |
| 1918 | 15,495 | 9,522,934 | 2,455 | 799,318 | 19,483,146 | 29,805,398 |
| 1919 | 3,885 | 2,310,561 | 661 | 176,028 | 11,426,289 | 13,912,878 |
| 1920 | 2,905 | 1,671,608 | 1,030 | 254,189 | 13,202,854 | 15,128,651 |
| 1921 | 1,437 | 741,110 | 2,969 | 405,871 | 7,123,366 | 8,270,347 |
| 1922 | 1,830 | 635,449 | 3,147 | 514,322 | 7,675,979 | 8,825,750 |

*Foreign zinc exported from the United States in 1917–1922.*

| Year. | Exported from warehouse. | | | Exported in manufactures with benefit of drawback, slabs and sheets excluded (short tons). |
|---|---|---|---|---|
| | Blocks, pigs, and old. | | All other manufactures. | |
| | Short tons. | Value. | | |
| 1917 | 64,680 | $12,429,356 | $50 | 1,588 |
| 1918 | 20,069 | 3,565,127 | ..... | 6,337 |
| 1919 | 12,256 | 1,943,507 | 13,071 | 4,533 |
| 1920 | 28,132 | 4,331,636 | ..... | 237 |
| 1921 | 1,256 | 100,677 | 10,785 | 130 |
| 1922 | 3,471 | 429,122 | 30,227 | 1,298 |

*Domestic and foreign zinc exported from the United States, 1921 and 1922, by destination.*

[Figures in parentheses are not duplicated in the totals.]

| Destination. | Domestic. | | | | Foreign (slabs). | |
|---|---|---|---|---|---|---|
| | Slabs. | | Sheets. | | | |
| | Short tons. | Value. | Short tons. | Value. | Short tons. | Value. |
| **1921.** | | | | | | |
| Africa | | | 1 | $567 | | |
| Asia | 919 | $105,320 | 129 | 41,060 | 1,120 | $89,467 |
| China | (100) | (16,079) | (20) | (6,839) | | |
| Japan | (819) | (89,241) | (96) | (29,592) | (1,120) | (89,467) |
| Australia and Oceania | 9 | 1,796 | 101 | 29,842 | | |
| Philippine Islands | (6) | (817) | (66) | (15,046) | | |
| Canada | 106 | 10,893 | 808 | 159,268 | 136 | 11,210 |
| Cuba | (a) | 40 | 35 | 10,271 | | |
| Europe | 470 | 55,918 | 206 | 56,217 | | |
| Belgium | (110) | (13,067) | | | | |
| France | (280) | (32,007) | | | | |
| Italy | | | (23) | (5,308) | | |
| Great Britain | | | (178) | (50,105) | | |
| Spain | (73) | (9,648) | | | | |
| Mexico | 206 | 24,106 | 313 | 69,380 | | |
| Panama | | | 31 | 6,590 | | |
| South America | 39 | 6,447 | 105 | 32,354 | | |
| Argentina | | | (26) | (10,585) | | |
| Brazil | | | (3) | (1,112) | | |
| Chile | | | (9) | (2,527) | | |
| Colombia | | | (27) | (7,017) | | |
| Peru | | | (34) | (9,017) | | |
| Other countries | 4 | 464 | 87 | 20,069 | | |
| | 1,753 | 204,984 | 1,816 | 425,618 | 1,256 | 100,677 |
| **1922.** | | | | | | |
| Africa | | | 3 | 727 | | |
| Asia | 7,487 | 805,748 | 322 | 46,456 | 224 | 22,175 |
| China | (1,323) | (155,849) | (11) | (3,697) | | |
| Japan | (6,060) | (638,867) | (255) | (31,289) | (224) | (22,175) |
| Philippine Islands | (a) | (532) | (44) | (8,131) | | |
| Australia and Oceania | | | 54 | 17,163 | | |
| Canada | 464 | 52,674 | 1,282 | 202,149 | 50 | 5,950 |
| Cuba | (a) | 34 | 149 | 25,560 | | |
| Europe | 18,202 | 2,058,902 | 757 | 163,335 | 3,044 | 381,231 |
| Belgium | (1,834) | (240,758) | (56) | (6,158) | | |
| France | (8,282) | (938,978) | (75) | (13,674) | (784) | (82,306) |
| Italy | (319) | (33,101) | (2) | (690) | (196) | (19,665) |
| Great Britain | (7,342) | (793,207) | (593) | (133,405) | (2,021) | (274,335) |
| Spain | (128) | (14,415) | (5) | (1,495) | (43) | (4,925) |
| Mexico | 415 | 49,685 | 375 | 58,977 | 119 | 15,845 |
| Panama | | | 9 | 1,666 | | |
| South America | 234 | 26,373 | 142 | 35,768 | 34 | 3,921 |
| Argentina | (174) | (19,034) | (29) | (7,024) | | |
| Brazil | (45) | (5,359) | (45) | (12,811) | (34) | (3,763) |
| Chile | (15) | (1,923) | (7) | (2,009) | | |
| Colombia | (a) | (13) | (33) | (6,406) | | |
| Ecuador | | | (2) | (453) | (a) | (158) |
| Peru | (a) | (44) | (14) | (3,633) | | |
| Other countries | 13 | 1,209 | 124 | 22,690 | | |
| | 26,815 | 2,994,625 | 3,217 | 574,491 | 3,471 | 429,122 |

a Less than 1 ton.

## CUSTOMS DUTIES ON ZINC.

In the following tables are shown the duties on zinc in ore and as metal imposed in the tariff acts of 1909, 1913, and 1922. As the duties levied on zinc in the tariff act of 1913 were to be computed ad valorem, for the sake of easy comparison the average duty collected over the whole period that the tariff of 1913 was in effect (October 3, 1913, to September 21, 1922) has been calculated. The total duty collected

has been divided by the total number of pounds of zinc in each class to obtain the average duty collected per pound, and this has been inserted in the table in parentheses as comparable with the specific duties of other tariffs.

*Tariff imposts on zinc in acts of 1909, 1913, and 1922, in cents per pound.*

| | 1909 | 1913 | 1922 |
|---|---|---|---|
| Ore, zinc content less than 10 per cent | Free. | 10% | Free. |
| 10 to 20 per cent | ¼¢ | 10% ( ½¢+ ) | ½¢ |
| 20 to 25 per cent | ½¢ | 10% ( ½¢+ ) | 1¢ |
| 25 per cent or more | 1¢ | 10% ( ½¢+ ) | 1½¢ |
| Slab zinc | 1⅜¢ | 15% ( ⅜¢+ ) | 1¾¢ |
| Zinc dust | 1⅜¢ | 15% (1¼¢−) | 1¾¢ |
| Sheets, plain | 1⅜¢ | 15% ( ⅜¢−) | 2¢ |
| Old and worn out | 1¢ | 15% ( ⅝¢+) | 1½¢ |

## CONSUMPTION.

*Primary zinc consumed in the United States, 1917–1922, in short tons.*

| | 1917 | 1918 | 1919 | 1920 | 1921 | 1922 |
|---|---|---|---|---|---|---|
| Supply: | | | | | | |
| Stock Jan. 1— | | | | | | |
| In bonded warehouses | 90 | 32 | | | | 131 |
| At smelters | 17,508 | 53,689 | 41,241 | 36,793 | 71,037 | 70,321 |
| Production | 669,573 | 517,927 | 465,743 | 463,377 | 200,500 | 354,277 |
| Imports, foreign | 257 | 35 | 70 | 15 | 6,739 | 52 |
| Imports, domestic, returned | | | | 8,162 | 731 | |
| Total available | 687,428 | 571,683 | 507,054 | 508,347 | 279,007 | 424,781 |
| Withdrawn: | | | | | | |
| Exports, foreign, from warehouse | 64,680 | 20,069 | 12,256 | 28,132 | 1,256 | 3,471 |
| Exports, foreign, under drawback | 1,588 | 6,337 | 4,533 | 237 | 130 | 1,298 |
| Exports, domestic | 153,796 | 80,244 | 129,508 | 85,898 | 3,569 | 30,032 |
| Stock Dec. 31— | | | | | | |
| In bonded warehouses | 32 | | | | 131 | 80 |
| At smelters | 53,689 | 41,241 | 36,793 | 71,037 | 70,321 | 16,810 |
| Total withdrawn | 273,785 | 147,891 | 183,090 | 185,304 | 75,407 | 51,691 |
| Apparent consumption | 413,643 | 423,792 | 323,964 | 323,043 | 203,600 | 373,090 |

## PRICES AND VALUE.

The fluctuations in the quoted price of the prime western grade of zinc at St. Louis are illustrated in Figure 2, which shows graphically for the years 1921 and 1922 the relations of the average weekly St. Louis quoted price of zinc, the weekly average London price of zinc, the weekly average price of 60 per cent zinc blende concentrates at Joplin, Mo., and the weekly sales of concentrates in the Joplin region as a whole. The price of zinc has been taken from market reports; the price of zinc blende and the figures of weekly sales are those published in the Joplin daily papers. To eliminate the sharp weekly fluctuations and to obtain a curve more easily comparable with the price curves, the weekly sales have been averaged by months, the result being shown by the broken line.

The average quotation for prime western zinc at St. Louis in 1922 was 5.7 cents a pound, compared with 4.7 cents in 1921 and 7.8 cents in 1920. The London average quotation for the year was £29 15s. a long ton, compared with £26 4s. 1d. a long ton in 1921.

A canvass of the actual sales of zinc and the prices received in 1922 gives 5.7 cents a pound as the average selling price of all grades. The average selling price for all grades is the price used in calculating the value of the zinc output of the country.

*Prices of zinc, by grades, 1917–1922, in cents per pound.*

[Average price received except as otherwise stated.]

| | 1917 | 1918 | 1919 | 1920 | 1921 | 1922 |
|---|---|---|---|---|---|---|
| Grade A (high grade) | 14.0 | 11.1 | 8.3 | 8.4 | 5.6 | 6.0 |
| Grade B (intermediate) | 12.7 | 10.7 | 7.7 | 8.3 | 5.5 | 6.0 |
| Grade C (select and brass special) | 9.4 | 8.0 | 7.2 | 8.2 | 4.9 | 5.6 |
| Grade D (prime western) | 9.0 | 7.9 | 7.1 | 8.0 | 4.9 | 5.6 |
| All grades | 10.2 | 9.1 | 7.3 | 8.1 | 5.0 | 5.7 |
| Prime western, average spot quotation at St. Louis | 8.9 | 8.0 | 7.0 | 7.8 | 4.7 | 5.7 |

Figure 3 shows graphically the average of weekly quotations for prime western slab zinc for prompt delivery at St. Louis and on the same vertical scale the weekly quotations on zinc sheets and zinc dust. The curve for slab zinc is irregular and shows quotations varying daily, but the curves showing quotations on zinc sheets and zinc dust are horizontal for weeks at a time. It should be borne in mind, however, that the quotations on zinc sheets are subject to discounts and that the discounts may fluctuate while the base quotation remains steady.

*Distilled and electrolytic zinc produced in the United States, 1917–1922.*

| Year. | Domestic primary. | | Foreign primary. | | Redistilled secondary. | | Total. | |
|---|---|---|---|---|---|---|---|---|
| | Short tons. | Value.[a] | Short tons. | Value.[a] | Short tons. | Value.[a] | Short tons. | Value.[a] |
| 1917 | 584,597 | $119,258,000 | 84,976 | $17,335,000 | 16,835 | $3,434,000 | 686,408 | $140,027,000 |
| 1918 | 492,405 | 89,618,000 | 25,522 | 4,645,000 | 9,918 | 1,805,000 | 527,845 | 96,068,000 |
| 1919 | 452,272 | 66,032,000 | 13,471 | 1,967,000 | 19,748 | 2,883,000 | 485,491 | 70,882,000 |
| 1920 | 450,045 | 72,907,000 | 13,332 | 2,160,000 | 21,371 | 3,462,000 | 484,748 | 78,529,000 |
| 1921 | 198,232 | 19,823,000 | 2,268 | 227,000 | 17,573 | 1,757,000 | 218,073 | 21,807,000 |
| 1922 | 353,274 | 40,273,000 | 1,003 | 114,000 | 32,988 | 3,761,000 | 387,265 | 44,148,000 |

[a] Value based on the average selling price for all grades.

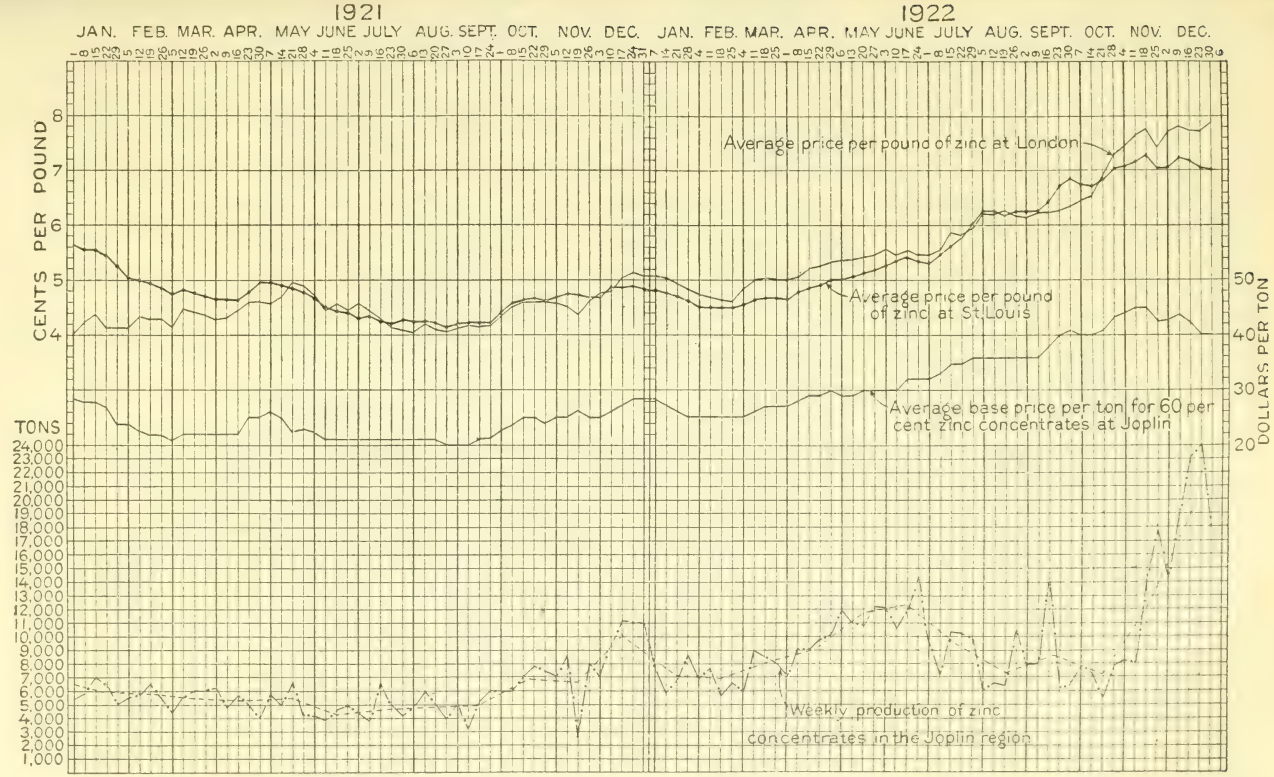


FIGURE 2.—Average weekly quoted price of zinc at St. Louis and London and of 60 per cent zinc concentrates at Joplin and weekly "production" (sales) of zinc concentrates in the Joplin region, 1921–1922.

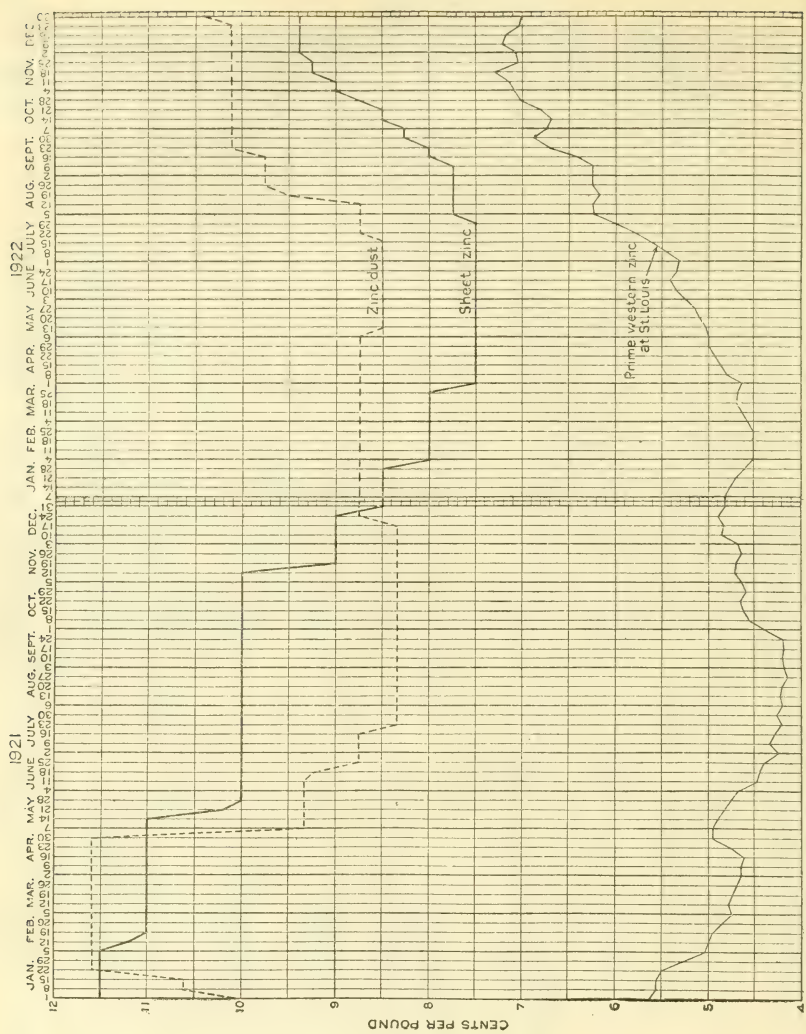


FIGURE 3.—Graphs showing relation of prices of metallic zinc products to the price of prime western spelter in 1921 and 1922 at St. Louis.

# ARSENIC.

By V. C. Heikes and G. F. Loughlin.

## PRODUCTION.

The output of refined and crude arsenic in the United States in 1922, according to final reports received from producers, amounted to 9,350 short tons. Arsenic from stocks on hand increased the available supply to 10,027 tons, all of which was sold for $1,475,229, or an average of 7.36 cents a pound. The sales of crude arsenic, 70 to 94.8 per cent pure, amounted to 1,122 tons, which was sold at an average of 6.2 cents a pound. Most of the output was converted at the point of production into sodium arsenite for weed killing, and some of it that was sold in small lots was exported for agricultural uses. The sales of white or refined arsenic, 99.5 per cent pure, amounted to 8,905 short tons, valued at $1,336,041, or 7.50 cents a pound.

Red sulphide or realgar recovered from ore treated by flotation at Gold Bar, Wash., was placed on the market to compete with the sublimed product shipped from Germany. No elemental arsenic was reported except some metal from Germany that was resold.

The table below includes the production of arsenic from all sources in the United States from the opening of the first plant at Everett, Wash., in 1901, to the end of 1922:

*Crude and refined white arsenic produced in the United States and imported, 1901–1922.*

| Year. | Domestic sales. | | | | Imports. | |
|---|---|---|---|---|---|---|
| | Short tons. | | Value. | | Short tons. | Value. |
| | Refined. | Crude. | Total. | Average (cents per pound). | | |
| 1901–1918 | [a] 46,239 | 705 | $4,506,786 | 4.800 | [b] 24,939 | [b] $2,332,681 |
| 1919 | [a] 6,029 | ..... | 1,181,684 | 9.800 | 4,389 | 624,494 |
| 1920 | 10,942 | 560 | 2,021,356 | 8.787 | 3,740 | 532,635 |
| 1921 | 3,427 | 1,359 | 717,700 | 7.498 | 1,669 | 253,250 |
| 1922 | 8,905 | 1,122 | 1,475,229 | 7.356 | 1,081 | 162,494 |

[a] Part of the output in 1918 and 1919 was elemental arsenic, but the elemental arsenic produced in 1920 and 1921 is not included in the table, as it was reduced from white arsenic purchased on the market. No elemental arsenic was produced in 1922.

[b] Imports for 1901 and 1902 (7,550 tons, valued at $596,580) include also arsenic sulphide. Separate figures not available.

## IMPORTS AND EXPORTS.[1]

*Arsenic compounds imported and entered for consumption in the United States, 1919–1922.*

| Year. | Arsenic and sulphide of, or orpiment. | | Sheep dip. | | Paris green and London purple. | |
|---|---|---|---|---|---|---|
| | Short tons. | Value. | Pounds. | Value. | Pounds. | Value. |
| 1919 | 2,151 | $316,687 | 146,803 | $12,346 | 18 | $14 |
| 1920 | 4,080 | 684,016 | 70,168 | 5,150 | 772 | 277 |
| 1921 | 3,343 | 531,322 | 61,377 | 6,362 | 325 | 123 |
| 1922[a] | 3,815 | 472,044 | 70,390 | 4,877 | 3,866 | 741 |

[a] Also 41,296 pounds of "acid," valued at $4,195, and 22,487 pounds of "metallic arsenic," valued at $3,484, imported Sept. 22 to Dec. 31, 1922. Not separately classified prior to new tariff.

*Foreign arsenic and sulphide of, or orpiment, exported, 1914–1922.*

| Year. | Pounds. | Value. | Year. | Pounds. | Value. |
|---|---|---|---|---|---|
| 1914 | 700 | $79 | 1919 | | |
| 1915 | 9,776 | 526 | 1920 | 13,799 | $1,827 |
| 1916 | 1,761 | 1,256 | 1921 | 23,765 | 2,835 |
| 1917 | 113,600 | 15,840 | 1922 | 14,290 | 1,555 |
| 1918 | 80,050 | 12,017 | | | |

## WHITE ARSENIC.

Arsenic trioxide, or arsenious oxide ($As_4O_6$; usually written $As_2O_3$), is perhaps the most common compound of arsenic, and in commerce it is often called "white arsenic" or simply arsenic. The term "arsenious acid" is frequently but erroneously used for "white arsenic," probably because aqueous solutions of arsenious oxide exhibit a feebly acid reaction. Arsenious acid[2] has never been isolated, because the solution, on concentration, deposits crystals of the trioxide.

Most of the world's supply of arsenic is recovered as a by-product from the smelting of ores containing other metals. It is put on the market in various forms but most commonly as arsenic trioxide, the "white arsenic" of commerce. White arsenic, or "prime white," as some dealers term it, is sold as a heavy white powder or in white, glassy, translucent masses and is usually very pure, containing 99.7 per cent or more of $As_2O_3$.

Six western smelting plants that handle copper and lead ores and are equipped with arsenic refineries made crude and refined white arsenic in 1922. The American Smelting & Refining Co., which operates arsenic refineries at Globe, Colo., Tacoma, Wash., and Perth Amboy, N. J., reported the largest output. The Anaconda Copper Mining Co. had difficulty in getting labor to mine sufficient ore to operate its ore-reduction plants at Anaconda, Mont., at greater capacity, but reported the second largest output of refined arsenic and the largest output of unrefined arsenic. The International plant of this company at Tooele, Utah, also produces unrefined arsenic.

[1] Figures compiled by J. A. Dorsey, of the United States Geological Survey, from the records of the Bureau of Foreign and Domestic Commerce, Department of Commerce.

[2] Mellor, J. W., Modern organic chemistry, p. 614, 1920.

At the plant of the United States Smelting, Refining & Mining Co. at Midvale, Utah, the output consisted of refined white arsenic, of which a normal quantity was sold, and crude material, all of which was worked up into sodium arsenate solution, many thousand gallons of which was distributed to railroad companies for killing weeds on rights of way. This weed killer is also made in large quantities by other firms, which purchase crude arsenic from the producers in Utah and Montana for shipment to their plants. Arsenical flue dust, precipitated fume, and speiss, containing from 30 to 75 per cent of $As_2O_3$, shipped from Murray, East Helena, Leadville, Selby, and Omaha, were refined in 1922 either at Tacoma or at Globe.

## ARSENIC MARKET IN 1922.

### DEMAND AND SUPPLY.

The use of arsenic in the United States and abroad in weed-killing compounds increased during 1922. In the cotton-growing area of the Southern States the boll weevil is being fought with calcium arsenate, of which about 8,000 tons (equivalent to 3,600 tons of white arsenic) was distributed to the cotton growers in 1922. Calcium arsenate was first used as an insecticide in 1919. Manufacturers laid in supplies of refined white arsenic in 1920, in anticipation of a large demand for calcium arsenate in 1921. They planned to sell their product at a price determined on the assumption that cotton would sell at 45 cents a pound, but the price of cotton later dropped to 12 cents a pound and the cotton growers were unable to purchase calcium arsenate. The manufacturers were therefore left with large stocks on hand in 1922. The large amount distributed by one manufacturer at a price below cost discouraged other manufacturers from making it, but when the supply became exhausted and the demand was again acute, they rushed into the market for white arsenic and manufactured as much as they could through the remainder of the season. This changed condition was reflected in the price of refined white arsenic in 1922. Until the early fall it was not high enough to encourage production. It then began to increase, but not fast enough to stimulate production to the maximum until December.

In 1922 about five times as much lead arsenate was made as all the other arsenical compounds combined, including calcium arsenate, Paris green, and Bordeaux mixture. The reports indicate that during the period from October 1, 1922, to May 1, 1923, the output of calcium arsenate has been larger and that of lead arsenate somewhat smaller than heretofore. The makers of plate glass bought their usual quantity of refined arsenic in 1922, or about 1,500 tons.

Though the unusually large demand for arsenical compounds for use as insecticides was doubtless the principal cause of the shortage of arsenic in 1922, there were several other causes. Among these are the reduction in 1921 and the first part of 1922 in the quantity of copper ores treated at Anaconda, Mont., and Tacoma, Wash., and the small supply of arsenical dust from the lead smelters in Montana, Utah, and Colorado; also the decrease in the imports in 1922. The minimum possible demand for arsenic in 1923 was estimated at the end of 1922 to be about 13,000 tons, including 2,000

tons for plate-glass manufacturers, 3,000 tons for lead arsenate, 3,500 tons for calcium arsenate, 1,500 tons for weed killers, 1,200 tons for Paris green, 1,000 tons for sheep dips, and 750 tons for proprietary mixtures. More recent information, however, indicates twice as great a demand for calcium arsenate.

The available supply of white arsenic from both domestic production and imports in 1921 amounted to only 6,455 tons. The supply increased in 1922, because of increased domestic production, and amounted to 11,108 tons.

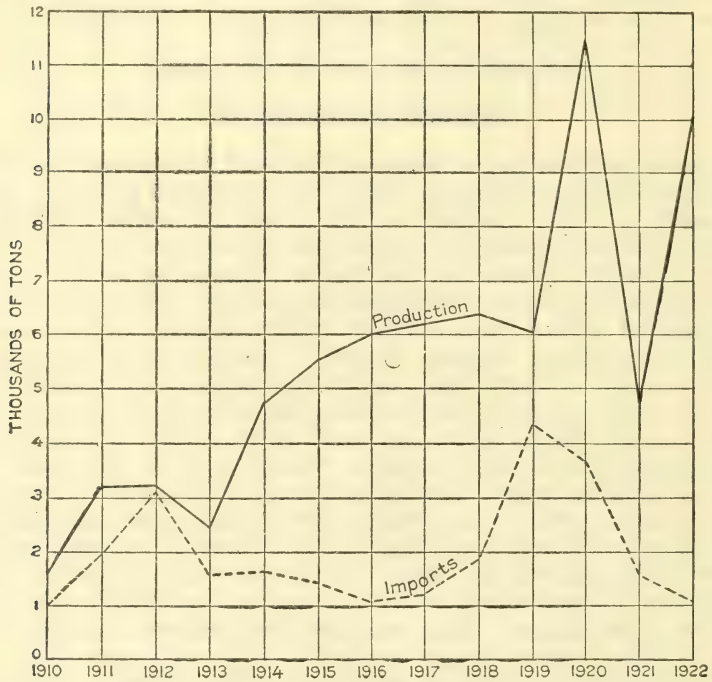


FIGURE 4.—Sales and imports of white arsenic, 1910–1922.

## PRICES.

During the last four years (see fig. 5) the highest price for white arsenic was 16 cents a pound, in July, 1920. Many of the insecticide makers bought arsenic at that price and made it into calcium arsenate, which was reported to have been sold at a loss.

The price of white arsenic in New York in 1922 ranged from 6 cents a pound in January to 15½ cents a pound in December. In July the price was 7¾ cents; in August it suddenly jumped to 8½ cents a pound, just as the manufacturers of insecticides decided to buy; and thereafter it rose rapidly until December. The average price to consumers, however, seems to have been between 7 and 7¾ cents, and the maximum price for wholesale lots is understood to have been 8½ cents. Contracts were said to have been made in October for German and Japanese white arsenic to be delivered in November and December at 9½ to 10 cents a pound.

Lead arsenate, powdered, was quoted at 13½ to 20½ cents a pound. Red arsenic was quoted at 12 to 13 cents a pound. The quotations on calcium arsenate ranged from 11 to 20 cents a pound, and at the end of November 10 to 12 cents was bid. Elemental arsenic was quoted at 17 cents a pound until March and at 24 cents from September 20 to the end of the year.

## FREIGHT RATES.

Freight charges are an important item in the distribution of arsenic, and cheap water transportation enables the foreign product to compete with the domestic in favorably located consuming centers.

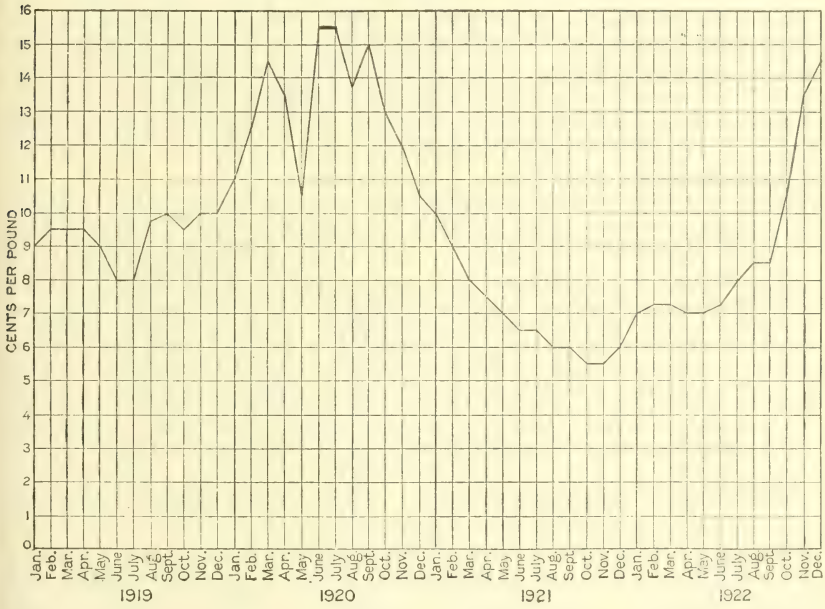


FIGURE 5.—Quoted wholesale prices of white arsenic, 1919–1922. (1919 from National Bank of Commerce, New York; 1920–1922 from Chem. and Met. Engineering, Dec. 20, 1922, p. 1241.)

Thus Canadian arsenic from the Cobalt district finds its way into the central area of the United States south of the Great Lakes, and Mexican supplies come by boat from Tampico to ports on the Atlantic seaboard. Many American smelters at which arsenic is recovered and many of the arsenic mines are far from the chief consuming centers in the eastern part of the country.

During 1922 railroad rates were lowered on crude and white arsenic in paper-lined barrels or casks from points in Colorado and Utah to the eastern coast and intermediate points east of Chicago and St. Louis. The rate for a minimum weight of 50,000 pounds ranged from $10.40 to $12 a ton from Colorado and from $12.75 to $14.15 a ton from Utah. The rate from Utah producing points to Missouri River, St. Paul, Chicago, and St. Louis was 60 cents a hundred for a minimum of 40,000 pounds. In March, 1923,

steamship rates from Pacific coast points to any point on the Atlantic coast ranged from 35 to 50 cents a hundred.

## OUTLOOK FOR 1923.

The production of refined white arsenic in March, 1923, was at a rate of about 15,000 short tons a year, and the information available indicated that, if a strong demand should continue throughout the year, as much as 20,000 tons of refined and 4,000 tons of crude white arsenic could be produced; but production for the first six months of 1923 was at the rate of only 12,000 tons of refined and 2,300 tons of crude arsenic. Unless the urgency of demand justifies, some of the refiners suspend operations during the hottest summer months. A slowing up of demand in April and May, 1923, with the expectation of a decline in price in August, has also had a retarding effect on some producers. This estimate does not include the output of several small operators who may be producing before the end of 1923. Imports, which have been coming in at the rate of 800 tons a month during 1923, may increase the total supply for the year to about 21,000 tons.

Owing to the high prices quoted for white arsenic in the United States, buyers of the products in New York City reported offers in December from several sources. Of Grecian arsenic, 1,000 tons annually was promised, and current supplies were offered from Australia, Belgium, Germany, and France. It is believed by some that, with the increased production of the United States, Mexico, and other countries, the potential supplies for 1924 are mounting fast, and that when consumption is interrupted in August, 1923, there may be a rather serious though temporary break in the market, after which the price of white arsenic will find its level somewhere between 8 and 10 cents a pound, and there will be an increased production from the main sources. Notes on the arsenic resources of foreign countries are given on pages 66–72.

The arsenic works already established can be enlarged, and others can be added to the great smelting plants in the United States and Mexico if the price of arsenic is stabilized. Direct production can not be expected to furnish cheap refined white arsenic, but the establishment of arsenic-treating plants to turn out a crude product would be distinctly advantageous to the miner, the consumer, and the smelter. For this purpose, and with a view of cheap treatment, it might be advisable to erect roasting furnaces and arsenic kitchens near several railway centers, so that mine owners might be encouraged to send to them ores and concentrates that contain precious and base metals combined with arsenic.

Arsenical sulphide ores would require little or no fuel, and where such ores are near a railway the calcines or residues from roasting operations may be smelted more cheaply than the original ore. However, developments of this sort are hazardous ventures on account of the uncertainty of a continued demand.

Alternative plans for combating the boll weevil which require less arsenic or none at all are continually being suggested, and the high price of arsenic resulting from the extensive application of calcium arsenate would itself be an added incentive to the discovery

of less expensive methods of dealing with the weevil. Some increase in foreign supplies may be expected if an attractive price is maintained, but it is unlikely that these sources could be relied upon to meet the situation wholly.

## ARSENIC ORES.

### OCCURRENCE AND DEVELOPMENT.

Important occurrences of arsenic minerals were discussed by Hess [3] in 1916 and by Emmons [4] in 1917. References to many other localities not mentioned in their reports are given in Bulletin 624 of the Geological Survey, entitled "Useful minerals of the United States." Additional information concerning occurrences and their development may be found in Part I of Mineral Resources for 1920 and 1921.

Arsenopyrite, or mispickel (sulphide of arsenic and iron), is more plentiful than all other arsenic minerals. It is found in many gold veins in the Western States and is also common in the Appalachian region. The mineral is easily distinguished from pyrite (disulphide of iron) by its silver-white color and the garlic odor which it yields when struck with steel. Economically important deposits of arsenopyrite occur in Canada, Mexico, France, Germany, Portugal, Spain, Italy, South Africa, Rhodesia, China, Queensland, Victoria, and Western Australia.

At certain mines in the United States whose ores contain arsenic minerals it may be found profitable to roast the ores and save the arsenic. Several years ago, for instance, roasting furnaces were added to the cyanidation mill at the Morro Velho gold mine, in the State of Minas Geraes, Brazil. The company treats annually about 150,000 tons of ore, and the output of white arsenic each of the last two years was 127 tons.[5] At Jardine, Mont., roasters and arsenic kitchens were under construction in January, 1923, to treat arsenopyrite concentrates averaging 38 per cent of arsenic. The Toulon arsenic plant (see p. 74), 10 miles east of Lovelock, Nev., produced crude and refined arsenic in 1922 from sulphide ores containing 15 to 18 per cent of arsenic. The other metals contained in the ore—gold, silver, and copper—remained in the calcines shipped to the smelter. The large dump of arsenical speiss at Eureka, Nev., which is now estimated at 50,000 tons, containing 30 per cent arsenic, furnished considerable arsenic to the Tacoma, Midvale, and Murray smelters. Arrangements were also made for the treatment of some of this material at Toulon, Nev.

A small quantity of white arsenic may be produced as a by-product from the ore reduced at the plant of the Tintic Standard Mining Co., at Harold, Utah. Bags for catching 1,000 pounds a day have recently been installed (April, 1923). Plans for several arsenic plants in South Dakota, Oregon, Washington, and British Columbia are being considered.

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[3] Hess, F. L., U. S. Geol. Survey Mineral Resources, 1914, pt. 1, p. 957, 1916.
[4] Emmons, W. H., The enrichment of ore deposits: U. S. Geol. Survey Bull. 625, pp. 402–408, 1917.
[5] St. John Del Rey Mining Co. (Ltd.) Ninety-first Ann. Rep., Feb. 28, 1922.

Early in the year high-grade material from the scorodite deposit at Gold Hill, Utah, was shipped to Baltimore for testing at the insecticide works of the General Chemical Co. The test was said to be satisfactory, and a plant for the manufacture of calcium arsenate (see p. 76) was completed at Salt Lake in January, 1923, by the Salt Lake Insecticide Co. The first shipment of calcium arsenate was made in April, 1923. A small deposit of scorodite of good grade, possibly not over 500 tons, was reported to have been discovered late in 1922 near Cima, Calif., and shipments of the mineral were made to a smelter in Utah.

Nothing has been accomplished with the deposits of arsenical ores at Brinton, Va., or in Putnam County, N. Y. It is considered doubtful whether arsenic can be economically produced from these sources until it is demonstrated that the price will remain at 10 cents a pound for a considerable time. This opinion is based on the fact that it would cost about $100,000 to start operations in either district.

## DISTRIBUTION BY STATES.

*Alaska.*—Arsenopyrite is the most abundant metallic sulphide in the gold quartz ores of the central and northern parts of Kenai Peninsula, Alaska.[6] The mineral occurs in association with the other sulphides in the veins of the region and also as striated crystals in the altered country rocks. At some places arsenopyrite, as well as sphalerite, galena, and pyrite, incloses native gold, but at others large masses of arsenopyrite show only a trace of gold upon assaying.

The gold quartz ores of the Valdez district[7] are in some places rather abundantly arsenical. In the Cliff mine, at Valdez, arsenopyrite occurs both in the gold-bearing quartz and in the adjacent country rock. The graywacke country rock impregnated with pyrite and arsenopyrite is not considered auriferous.

Arsenic occurs abundantly in the Fairbanks and Nome districts, but Mertie[8] doubts whether it could be profitably recovered except as a by-product of gold quartz mining. In the Fairbanks district arsenopyrite occurs in the Ryan lode and at some adjacent properties in the Ester Creek drainage basin. At Nome arsenopyrite is the most common sulphide at certain low-grade gold quartz prospects in the vicinity of Glacier and Rock creeks. It is also present to a smaller extent in the Solomon and Bluff districts.

*Arizona.*—Arsenical sulphides, associated with chalcopyrite and iron pyrite, are reported in the Tip Top district, Yavapai County, Ariz., and in the property of the Kay Copper Co.

*California.*—The Rand district is probably the greatest source of arsenic in California. The arsenic is contained in silver ore, of which a considerable part is milled, after which the concentrates are shipped to the smelter. The output of both ore and concentrate

[6] Martin, G. C., Johnson, B. L., and Grant, U. S., Geology and mineral resources of Kenai Peninsula, Alaska: U. S. Geol. Survey Bull. 587, p. 135, 1915; Brooks, A. H., and others, Mineral resources of Alaska, 1911; U. S. Geol. Survey Bull. 520, pp. 131–173, 1912.

[7] Johnson, B. L., Gold and copper deposits of Port Valdez district: U. S. Geol. Survey Bull. 622, pp. 140–188, 1915.

[8] Mertie, J. B., U. S. Geol. Survey Bull. 662, pp. 413–414; Bull. 722, pp. 188–254.

was large in 1921 and 1922, and according to a recent article[9] a penalty is placed on the antimony and arsenic content by the smelter. Some concentrate shipped from the Alleghany district, in Sierra County, is high in arsenic, but how much more the district is likely to produce than at present is uncertain. It has been the practice of the producers of high-grade gold ores in the Alleghany district to roast them locally to remove the arsenic and sulphur before the bullion is amalgamated, no provision being made for saving the arsenic.

Arsenic is contained in the concentrate recovered at milling works at Plymouth, in Amador County, which is said to carry 2 per cent of arsenopyrite. Near Valley Springs, in Calaveras County, ore occurs that carries 25 per cent of arsenic. One mine in Kern County, at Rosemont, has ore containing 30 per cent of arsenic, and at Mount Bullion, in Mariposa County, the concentrate product is arsenical. The gold and silver ores of smelting grade mined at Soledad, in Monterey County, and some ores mined near Quincy, in Plumas County, carry arsenic. A vein 20 feet wide near Escondido, in San Diego County, is said to have plenty of ore of 20 per cent grade. Arsenopyrite occurs with free gold ores mined near Downieville, in Sierra County, where conditions could probably be improved by roasting and saving the arsenic. Iron and arsenical sulphides are said to occur at Rollin, in Siskiyou County, and realgar has been reported near Skaggs Springs, in Sonoma County. A fair grade of arsenopyrite has been found near El Centro, Imperial County.

*Colorado.*—In Gunnison County, Colo., the White Iron Ores & Products Co. has produced arsenical iron ore containing from 15 to 30 per cent of arsenic. The property promises to be a source of white arsenic recovered locally. The mine is 2 miles from Madera, a loading point on the Denver & Rio Grande Western Railroad. Other deposits of arsenical pyrite were reported in Gunnison County, but no definite statement was made as to their size or location.

According to Henderson,[10] certain areas in Gilpin County contain more arsenic than others. On the edge of the Nevadaville district, in the Newfoundland, Dyke, and Ashtabula veins, the ores with the highest content of arsenic are found.

*Idaho.*[11]—Concentrates from the Talache Mines (Inc.), at Talache, Idaho, contain considerable arsenic and are probably shipped to Tacoma. The principal valuable mineral in the ore is freibergite, the silver-rich form of tetrahedrite. The other metallic minerals are pyrite and arsenopyrite, with smaller amounts of sphalerite, galena, and chalcopyrite, in a gangue of quartz and siderite. The arsenopyrite, although not conspicuous in the ore, furnishes a sufficient amount of arsenic to be worth considering at the present rate of shipment, which is reported to be about 20 tons a day.[12]

In one level of the Vulcan mine, near Lakeview, in the Pend Oreille region, the main vein, in which the valuable mineral is argentiferous galena, is flanked by a second vein carrying native arsenic

[9] Parsons, A. B., The California Rand silver mine: Min. and Sci. Press, vol. 124, pp. 11–12, Jan. 7, 1922.
[10] Henderson, C. W., personal communication, March, 1923.
[11] Written communication from Edward Sampson, of the United States Geological Survey.
[12] Eng. and Min. Jour.-Press, Sept. 30, 1922, p. 581.

as almost the sole metallic mineral. The arsenic-bearing vein is said to be of irregular thickness, with swells as much as 1 foot thick. This mine has been idle for a number of years, and no effort has been made to find a market for the arsenic.

*Montana.*—Arsenopyrite occurs abundantly in the ores at Jardine, in Park County, Mont., which have been a source of arsenic ever since concentrate containing gold has been shipped to Tacoma, Wash., where arsenic is a by-product of the smelter. In January, 1923, roasters and arsenic kitchens were under construction at Jardine, and the first output of white arsenic was made in March. Arsenic is contained in many of the ores mined in Jefferson County. Near Wickes the dump of the Atlas mine has considerable arsenopyrite, and in the Mitchell district the iron and arsenic sulphides are said to average 13 per cent of arsenic. At Philipsburg, in Granite County, the Granite-Bimetallic ore averages less than 1 per cent of arsenic, but the primary ores of this mine are said to average 5 per cent. At Butte enargite is the prominent arsenic mineral of the copper ores, and the concentrates from these ores are said to average 1 per cent of arsenic.

*Nevada.*—Realgar and orpiment are prominent in the White Caps mine at Manhattan, Nev., and have been mined at different times for their arsenic content. These minerals have been found mainly in the eastern part of the mine, between the 550 and 800 foot levels. On the 920-foot level they are very scarce. It is expected that about 10 tons a month of relatively pure realgar and orpiment can be sorted from the ore after primary crushing. The material will probably contain about 40 per cent of arsenic and very little gold. The milling ore, which is roasted before cyanidation, will probably average about 2 per cent of arsenic but is hardly worth recovery at present. The arsenic content of the ore as a whole is reported to decrease in depth.

Near Austin, in Lander County, veins of arsenical pyrite ranging from 4 to 16 inches in width are said to carry as high as $12.50 to the ton in gold and a little silver. Realgar and orpiment are also found, but not in quantity. The Battle Mountain district is the source of most of the arsenic recovered at the Toulon arsenic works. Near Carson City, in Ormsby County, some arsenopyrite has been found, and at the old Galena mine, south of Reno, a large quantity of arsenical ore is said to occur. The ores at Eureka carry considerable arsenic, and the old smelter dumps still contain a large quantity of speiss.

*New Mexico.*—In the Magdalena district, N. Mex., near Water Canyon, ore occurs that carries arsenical sulphides and is of concentrating grade. There is plenty of water near the ore deposit, which is 4 miles from the railroad.

*New York.*—Near Pine Pond, in the town of Kent, Putnam County, N. Y., arsenopyrite occurs with chalcopyrite in a vein of white quartz close to a serpentinized basic dike. Hand-picked ore contained 25 per cent of arsenic. Arsenopyrite was also reported[13] near Edenville and at other places in Orange County and in the town of Lewis, Essex County, 10 miles south of Keeseville. At Edenville it is associated with leucopyrite and scorodite, and the wall rock is crystalline limestone.

[13] Newland, D. H., Arsenical ore: New York State Mus. Bull. 112, pp. 10–12, 1907.

*Oregon.*—Realgar and orpiment in considerable quantity are reported near Oakland, in Douglas County, Oreg., but the deposits were never worked for the minerals. In Grant County, at Prairie City and at Austin, some arsenical ores are found. Quicksilver ores of the War Eagle mine, near Medford, were roasted, and the flue dust that was saved was said to contain 80 per cent of $As_2O_3$. Pardee and Hewett [14] state that most of the concentrate shipped and many of the ores from the lodes of the Sumpter district contain considerable arsenopyrite, the arsenic from which, under favorable smelting conditions, could be recovered at a profit. Early in 1923 it was reported that arsenical concentrates were being shipped from this district to the Tacoma smelter.

*Southern Appalachian States.*—White arsenic was formerly recovered from arsenopyrite ore mined at Brinton, Va.,[15] but the mine has been idle for several years. Arsenic minerals are present in the gold fields of the southern Appalachian region [16] and might justify investigation, but the quantity of ore mined during the last 10 years or more is too small to have been an important source of arsenic.

Arsenic minerals have been noted at a number of places in this region. Scorodite was recorded by Dana in 1892 as occurring in the Ludwick mine, in Cabarrus County, N. C. Arsenopyrite (mispickel) was noted in 14 mines, of which 1 was in Virginia, 8 in North Carolina, 4 in Georgia, and 1 in Alabama.

*Utah.*—Arsenic is present in many of the ores of Utah, notably those of the Tintic district, which have been the principal source of arsenic as a by-product at the smelters. Arsenic also occurs in the ores of the Little Cottonwood and Clifton districts. The Clifton district is the principal source of the hydrous ferric arsenate, scorodite,[17] but this mineral has also been found in the West Tintic, Tintic, Star, and Mercur districts. Realgar has been noted in the Bull Valley district, Washington County, by Butler,[18] who says that the deposit occurs in sandy sediments in a breccia zone that crops out in the bed of Arsenic Canyon.

In the Camp Floyd district, principally at Mercur and Sunshine, the gold ores contained considerable realgar and orpiment, and certain ores treated by cyanidation required roasting. Considerable white arsenic, noted by the writer, was caught in the flues of the Golden Gate roasters at Mercur and allowed to go to waste. These mines were operated between 1903 and 1913 but are now abandoned. In Coyote Creek, Garfield County, is another occurrence of realgar, in the vicinity of the antimony deposits, though not visibly connected with them.[19]

*Washington.*—Many of the ores of Washington contain arsenic—some of them in sufficient quantity to make it a source of profit. The ores of the Monte Cristo district are rich in arsenic, which carries with it much of the gold of the district. These ores were treated

[14] Pardee, J. T., and Hewett, D. F., Geology and mineral resources of the Sumpter quadrangle, Oreg.: Oregon Bur. Mines and Geology Bull. 6, October, 1914.

[15] Hess, F. L., The arsenic deposits of Brinton, Va.: U. S. Geol. Survey Bull. 470, pp. 204–211, 1911.

[16] Becker, G. F., Gold fields of the southern Appalachians: U. S. Geol. Survey Sixteenth Ann. Rept., pt. 3, pp. 251–331, 1895.

[17] Butler, B. S., Ore deposits of Utah: U. S. Geol. Survey Prof. Paper 111, pp. 114, 483, 1920.

[18] Idem, p. 598.

[19] Richardson, G. B., Antimony in southern Utah: U. S. Geol. Survey Bull. 340, pp. 253–256, 1908.

for a number of years at the smelter of the Puget Sound Reduction Co., at Everett, Snohomish County, and for some time the arsenical gases from the roasters were allowed to escape into the air, but in 1901 a plant for collecting and refining arsenic was installed, and Washington had the distinction of being the first State in the Union to produce white arsenic on a commercial scale. The Everett smelter has since been dismantled, but a larger arsenic plant has been operating for several years at the Tacoma smelter, where refined white arsenic is produced.

Arsenical ores occur also in many other parts of the Cascade Mountains in northeastern Washington. They are found near Berlin, King County; in the Twisp and Squaw Creek districts, Okanogan County; and in the Stilaguamish district, Snohomish County. In addition to ores carrying arsenic as an accessory mineral, deposits of realgar, arsenic sulphide, exist in a number of places in the State. Perhaps the best known of these is at Mineral, in northern Lewis County, where white arsenic was produced for a time. Another deposit of realgar occurs near Clear Lake, in Skagit County, but so far as the writers know it has not been worked on a commercial scale. Realgar is known to occur also in the Monte Cristo district.

Ore containing realgar has been concentrated by flotation during 1922 at Gold Bar, Wash., and the output during the time of operation was more than a ton of realgar a day. The ore[21] occurs along a faulted and brecciated zone in diorite. The sulphide is partly in massive form in veins about a foot wide and partly distributed as individual crystals in diorite.

## WORLD'S PRODUCTION.

The foreign contributions to our supplies of white arsenic have been important in helping to meet the shortage of calcium arsenate early in 1923, and shortly before that they were sufficient to cause agitation for a protective tariff. At present the market can absorb both the domestic and the imported white arsenic, but as domestic production increases competition between the foreign and domestic products may be expected, and available information on the production and resources of foreign countries will therefore be of interest.

*World's production of arsenic ore and white arsenic, 1913–1921, in metric tons.*

| Country and kind of ore (where specified). | 1913 | 1914 | 1915 | 1916 | 1917 | 1918 | 1919 | 1920 | 1921 |
|---|---|---|---|---|---|---|---|---|---|
| ORE.[a] | | | | | | | | | |
| Australia: | | | | | | | | | |
| New South Wales | ..... | ..... | ..... | ..... | ..... | ..... | 6 | (b) | 1,117 |
| Queensland (arsenical pyrites) | ..... | ..... | ..... | ..... | 33 | 202 | (b) | (b) | (b) |
| Victoria | (c) | (c) | (c) | (c) | (c) | (c) | (b) | (c) | (c) |
| Western Australia (ore exported) | ..... | ..... | ..... | 11 | 58 | 708 | ..... | 1,793 | 7 |
| Canada | (b) | (b) | (b) | (b) | (b) | (b) | (b) | (b) | (b) |
| China (exports) | d 547 | d 115 | d 58 | d 490 | d 310 | d 138 | e 225 | e 472 | e 258 |
| France | 4,427 | 250 | 1,300 | 1,800 | 344 | 728 | 600 | 280 | 580 |

(See footnotes at bottom of table on opposite page.)

[21] Eakin, H. M., personal communication to the Director, U. S. Geol. Survey, Aug. 29, 1922.

*World's production of arsenic ore and white arsenic, 1913–1921, in metric tons*—Continued.

| Country and kind of ore (where specified). | 1913 | 1914 | 1915 | 1916 | 1917 | 1918 | 1919 | 1920 | 1921 |
|---|---|---|---|---|---|---|---|---|---|
| ORE—continued. | | | | | | | | | |
| Germany | 5,721 | 4,732 | 4,085 | 3,674 | *f*39,092 | *f*49,800 | *f*26,068 | *f*38,400 | (*c*) |
| Greece | ..... | ..... | ..... | ..... | (*b*) | (*c*) | (*b*) | (*b*) | (*b*) |
| Japan | (*b*) | (*b*) | (*b*) | ..... | ..... | 247 | 968 | 2,173 | 1,506 |
| Mexico | ..... | ..... | ..... | ..... | (*b*) | (*b*) | (*b*) | (*b*) | (*b*) |
| Norway (arsenical pyrite) | ..... | ..... | ..... | ..... | ..... | 12 | 20 | ..... | ..... |
| Portugal | (*b*) | (*b*) | 146 | (*c*) | (*c*) | (*c*) | 62 | 62 | 11 |
| Rhodesia, Southern | ..... | 69 | ..... | ..... | ..... | 103 | 220 | 396 | 327 |
| Spain (arsenical pyrites) | (*b*) | (*b*) | (*b*) | (*b*) | (*b*) | 250 | 150 | 1,000 | ..... |
| Union of South Africa | ..... | ..... | ..... | ..... | (*b*) | (*b*) | (*b*) | (*b*) | (*b*) |
| United Kingdom (arsenical pyrites) | 36 | (*b*) | 428 | 305 | 441 | 485 | 76 | 1,197 | (*b*) |
| United States | (*b*) | (*b*) | (*b*) | (*b*) | (*b*) | (*b*) | (*b*) | (*b*) | (*b*) |
| WHITE ARSENIC.*g* | | | | | | | | | |
| Australia: | | | | | | | | | |
| New South Wales | ..... | ..... | ..... | ..... | ..... | ..... | (*h*) | 71 | 403 |
| Queensland | ..... | ..... | ..... | ..... | *i* 10 | 67 | 59 | 310 | 224 |
| Victoria | (*c*) | (*c*) | (*c*) | (*c*) | (*c*) | (*c*) | 1,041 | (*c*) | (*c*) |
| Western Australia | ..... | ..... | ..... | (*h*) | (*h*) | (*h*) | ..... | (*h*) | (*h*) |
| Canada | 1,535 | 1,576 | 2,174 | 1,983 | 2,663 | 3,230 | 3,075 | 2,231 | 1,353 |
| China (exports) | (*h*) | (*h*) | (*h*) | (*h*) | (*h*) | (*h*) | 58 | 49 | 100 |
| France | (*h*) | 132 | 323 | 874 | 677 | 993 | 735 | (*h*) | (*h*) |
| Germany | *i* 1,892 | *i* 1,637 | *i* 1,456 | *i* 1,280 | *i* 3,551 | *i* 4,401 | *i* 2,098 | *i* 2,610 | (*c*) |
| Greece | ..... | ..... | ..... | ..... | 436 | (*c*) | 686 | 969 | 768 |
| Japan | 21 | 15 | 15 | ..... | ..... | 213 | 835 | 933 | 1,406 |
| Mexico | ..... | ..... | ..... | ..... | 1,285 | 1,881 | 2,246 | 2,183 | 785 |
| Norway | ..... | ..... | ..... | ..... | ..... | (*h*) | (*h*) | ..... | ..... |
| Portugal | 925 | 960 | 859 | (*c*) | (*c*) | (*c*) | 536 | 653 | 268 |
| Rhodesia, Southern | ..... | (*h*) | ..... | ..... | ..... | (*h*) | (*h*) | (*h*) | (*h*) |
| Spain | 47 | 53 | 83 | 73 | 61 | 104 | 42 | 76 | ..... |
| Union of South Africa | ..... | ..... | ..... | ..... | 3 | 13 | 7 | 10 | 2 |
| United Kingdom | 1,722 | 2,020 | 2,536 | 2,586 | 2,668 | 2,387 | 2,568 | 2,029 | 1,049 |
| United States | 2,280 | 4,237 | 4,988 | 5,430 | 5,580 | 5,736 | 5,469 | 10,434 | 4,342 |

*a* In addition to the countries listed, Italy produced 3 metric tons of ore in 1919 and 60 tons in 1920.
*b* White arsenic reported.
*c* No data available.
*d* Arsenic trisulphide.
*e* Realgar.
*f* Crude ore mined.
*g* In addition to the countries listed, Austria reports arsenic slime from a gold mine in Nasfelde as follows: 1916, 18 tons; 1920, 46 tons; 1921, 54 tons. Brazil reports about 127 tons of white arsenic in 1920 and the same amount in 1921.
*h* Ore reported.
*i* Estimated arsenic in ore.

AUTHORITIES.

Australia: New South Wales, Dept. Mines Ann. Rept.; Queensland, Under Secretary for Mines Ann. Rept.; Victoria, Imperial Mineral Resources Bureau, London; Western Australia, Dept. Mines Rept.
Canada: Dept. Mines Ann. Rept.
China: 1913–1918, Imperial Mineral Resources Bureau, London; 1919–1921, Maritime Customs, Foreign Trade of China.
France: 1913–1919, Statistique de l'industrie minérale en France et en Algérie; 1920–21, official questionnaire from the Ministry of Public Works.
Germany: 1913–1918, Vierteljahrshefte zur Statistik des Deutschen Reichs; 1919, Statistisches Reichsamt; 1920, consular rept., Sept. 27, 1922.
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Japan: 1913–1917, Résumé statistique; Min. Ind. Br. of Mines, Dept. Agr. and Com.; 1918, English supplement; 1919–20, translation from Japanese; 1921, consular rept. Apr. 1, 1922.
Mexico: Boletín Minero, Departamento de Minas.
Norway: Bergverksdrift, Offisielle Statistikk.
Portugal: 1913–1915, Imperial Mineral Resources Bureau, London; 1919–1921, official questionnaire.
Rhodesia, Southern: Secretary for Mines Report.
Spain: Estadística minera de España.
Union of South Africa: Dept. Mines and Industries Ann. Repts.
United Kingdom: 1913–1920, Mines and Quarries Rept., pt. 3; 1921, Sec. Mines and H. M. Chief Insp. Mines First Ann. Rept.

The leading countries in production, as well as in shipments to the United States, are Canada, Mexico, the United Kingdom, Germany, and Japan; but no records are available to show the quantities of white arsenic received from each of them. Their order in the following descriptions, therefore, does not necessarily imply relative

economic importance. These descriptions are followed by available information on countries that produce less.

## PRINCIPAL FOREIGN COUNTRIES.

*Canada.*—The arsenic produced in Canada [22] is obtained largely in the smelting of silver-cobalt-nickel ores of the Cobalt district. The Hedley Gold Mining Co., in British Columbia, shipped some arsenical gold concentrates in 1922 to Tacoma, Wash. The report of the Canadian Department of Mines contains a table that is reprinted below, together with the figures of the preliminary report for 1922:

*Production, exports, and imports of arsenic in Canada, 1918–1922.*

| | 1918 | | 1919 | | 1920 | | 1921 | | 1922 | |
|---|---|---|---|---|---|---|---|---|---|---|
| | Quantity. | Value. | Quantity. | Value. | Quantity. | Value. | Quantity. | Value. | Quantity. | Value. |
| Production (short tons): | | | | | | | | | | |
| From arsenical concentrates | 1,078 | $43,114 | 530 | $21,218 | 628 | $22,231 | ..... | ..... | 518 | $21,097 |
| White arsenic | 2,482 | 520,525 | 2,859 | 488,706 | 1,831 | 425,617 | 1,491 | $233,763 | 2,058 | 299,940 |
| Exports (short tons): | | | | | | | | | | |
| Arsenic, metallic | ..... | ..... | ..... | ..... | ..... | ..... | ..... | ..... | 222 | 5,238 |
| Arsenic, not otherwise provided for | 2,672 | 393,883 | 2,506 | 355,654 | 1,655 | 313,311 | 767 | 108,535 | 1,367 | 198,005 |
| Imports (pounds): | | | | | | | | | | |
| White arsenic | 995 | 222 | 4,706 | 1,325 | 962 | 201 | 1,847 | 230 | 441,168 | 32,520 |
| Sulphide of arsenic | 301,985 | 33,351 | 304,694 | 26,613 | 337,153 | 43,445 | 185,685 | 26,348 | 525,246 | 39,264 |
| Arseniate of soda | 121 | 34 | 5,566 | 1,661 | 48,863 | 10,568 | 11,993 | 3,002 | 7,961 | 1,402 |

The Coniagas Reduction Co. (Ltd.) operated its refinery at Thorold, Ontario, during 1920, 1921, and 1922 on ores from the mines at Cobalt. White arsenic was recovered each year. The Deloro Smelting & Refining Co. (Ltd.) operated its smelter at Deloro, Ontario, in 1920, 1921, and 1922. In 1920 it treated 550 tons of ore, concentrates, and residues monthly. Besides silver, cobalt, and nickel alloys the plant makes white arsenic, Paris green, arsenate of lead, and arsenate of lime.

A report of the Canada Geological Survey [23] gives the following notes:

The Howry Creek gold-arsenic deposits are on the north side of Howry Creek, a tributary of Whitefish River, all being included in an area 6 miles long from east to west by 1 mile wide. The deposits are conveniently reached from Sudbury by way of the Algoma Eastern Railway, from mileage 64, on which a canoe trip of about two hours is necessary to cross Charlton Lake and to ascend Howry Creek.

The mineralized area is underlain by quartzite, graywacke, and conglomerate belonging to the upper part of the Gowganda formation and lower part of the Lorraine quartzite (Cobalt series). These formations lie on edge, strike east and west, and are intersected by a few dikes and larger bodies of diabase (Keweenawan). The ore deposits are chiefly well-defined quartz veins with a general east-west strike and nearly vertical dips. They are composed of white quartz and ankerite carrying arsenopyrite and free gold as their chief con-

[22] Mineral production of Canada, preliminary report, 1922, Ottawa, 1923.
[23] Canada Geol. Survey Summary Rept., 1917, pt. E.

stituents of possible commercial value. The wall rock, especially if it is graywacke or conglomerate, is bleached, heavily impregnated with ankerite, and slightly mineralized with the same ore minerals as the vein stuff for 2 or 3 feet on either side of the veins. One of the deposits * * * is simply a broad sheared zone in conglomerate which has been hydrothermally altered and filled with a plexus of quartz veinlets. The arsenopyrite in the Bousquet vein occurs as the usual grayish-white variety and also as a darker iron variety. It is the most abundant metallic constituent, being continuously exposed in massive form, 2½ to 18 inches wide, for a distance of 150 feet. Arsenopyrite is present in considerable quantity in other veins of the same general character. The genesis of the Howry Creek veins is unknown, but they are similar in composition to the ores of the Long Lake gold mine, 25 miles northeast, and in this interval other deposits may be found.

The gold-arsenopyrite type of deposit in the Hedley district of British Columbia is considered rare by Lindgren,[24] who reviews a descriptive article by Camsell [25] concerning the deposit worked in the Nickel Plate mine, British Columbia.

Gently folded Carboniferous limestones associated with shale, quartzite, and volcanic tuffs are intruded by sheets of gabbro and diorite. Along the contacts of these sheets, and particularly of their apophyses, the impure limestones are converted into contact-metamorphic minerals with arsenopyrite. The commercial ore bodies, which have yielded several million dollars in gold, are tabular and follow the dipping contacts of the basic rock, which are not exactly parallel with the inclination of the strata. The outside of the ore body is irregular and gradually fading, reaching somewhat farther away from the contact in some beds than in others. The principal ore body has been followed 350 feet along the dip and has a width parallel to the contact of 125 feet.

The ore minerals are, named in order of quantity, arsenopyrite, pyrrhotite, chalcopyrite, pyrite, zinc blende, tetradymite ($Bi_2Te_3$), and molybdenite. The depth of oxidation is slight, but in the upper levels free gold occurred associated with tetradymite, while at the greater depth now attained it seems to be intimately bound up with the arsenopyrite and is not amenable to amalgamation. The pure arsenopyrite may contain as much as 12 ounces of gold per ton. The gold tenor varies from $6 to $14 per ton, but beyond the ore body minor quantities of gold are widely disseminated in the contact-metamorphic rocks. There is very little silver; traces of platinum (as sperrylite?) and nickel are present. The gangue minerals are andradite, pyroxene, epidote, calcite, and axinite, and the sulphides are closely intergrown with them, pointing to contemporaneous deposition; the chalcopyrite is somewhat later than the arsenopyrite. Quartz is distinctly later than the other gangue minerals. Orthoclase appears in gabbro dikes replacing pyroxene by a process of endomorphic contact metamorphism. Although the rocks are faulted and fissured by postintrusive stresses, these fractures contain practically no valuable ores.

The only similar deposit described in the literature is that of Reichenstein, Silesia, the auriferous leucopyrite and arsenopyrite of which have been worked on a small scale, probably since the thirteenth century. According to C. Wienecke [26] and A. Bergeat,[27] the ore-producing intrusive is probably a neighboring granite and the altered rock a dolomitic limestone.

The Nickel Plate mine has been closed for some time but is about to be reopened, according to the American consul general at Ottawa.

*Mexico.*—Considerable white arsenic has been produced from ores treated at Mapimi, Mexico, but recently the arsenic content of the ores has decreased considerably. The American Smelting & Refining Co., however, plans to save arsenic at its Mexican smelting plants and has appropriated funds for the purpose. These plants are at Matehuala, Asarco, and Chihuahua.

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[24] Lindgren, Waldemar, Mineral deposits, pp. 696–697, 1913.
[25] Camsell, Charles, Geology and ore deposits of the Hedley mining district, British Columbia: Canada Geol. Survey Mem. 2 (No. 1093), 1910.
[26] Zeitschr. prakt. Geologie, 1907, p. 273.
[27] Die Erzlagerstätten, vol. 2, p. 1137, 1906.

*United Kingdom.*—Arsenical pyrite and white arsenic as a by-product are recovered in the mining and treatment of the tin ores of the Camborne-Redruth and Kit Hill-Colstock districts of Cornwall, where the ores contain a certain amount of arsenopyrite.

*Germany.*—There are three arsenic mines in Silesia, according to the American consul,[28] who reports as follows:

One mine is at Altenberg, another at Rothenzechan, and the Reiche Trost mine, situated close to Reichenstein, which furnish about 65 per cent of the total production. This mine has had a long and interesting career, dating back to the sixteenth century, from which period it has been continually the property of the Guettler family, the present owners and operators. The Reiche Trost was originally a very prosperous gold mine. Gold ore in paying quantities was exhausted in the early part of the seventeenth century, after which the mine was sporadically worked up to 1883, when attention was directed to the production of arsenic, which proved a success from the very beginning. To-day this mine is equipped on modern lines and is the mainstay of the city of Reichenstein. Industries consuming arsenic, such as black and smokeless powder mills, shot works, fuse works, metal-paint works, and potteries, are located in the vicinity of this mine.

The greater part of the output of the arsenic mines of Silesia is converted into arsenic acid for use in making insecticides. During the pre-war period about 2,500 tons of acid was annually exported overseas, mostly to the United States. During the war the output of these mines was used almost exclusively for the production of gray arsenic. From a normal production of 8 tons per month it was worked up to 400 tons per month.

At present the Guettler Works (Dr. Wilhelm Guettler and Dr. Gebhard Guettler, Reichenstein, Silesia, Germany) are owners and operators of two arsenic mines and lessees of the other one, whereby they control the output of arsenic in the Province of Silesia. In their Reichenstein interests they give employment to about 3,000 men and women.

The ores worked are auriferous leucopyrite and arsenopyrite.

*Annual production of arsenic ore from three mines in Silesia.*

| | 1913 | 1914 | 1919 | 1920 |
|---|---|---|---|---|
| Metric tons | 5,008 | 4,261 | 5,117 | 6,009 |
| Average value per ton.....marks.. | 77.21 | 76.79 | 423.85 | 1,204.29 |
| Employed: | | | | |
| Surface | 96 | 86 | 173 | 212 |
| Mine | 133 | 143 | 255 | 260 |

According to Lindgren,[29] the Reichenstein deposit is similar to that worked by the Nickel Plate mine, British Columbia.

*Japan.*[30]—Fairly large deposits of arsenic ore have been reported in the prefectures of Oita, Miyazaki, Hiroshima, Hyogo, Shimane, and Okayama, Japan. The arsenic content usually ranges from 15 to 30 per cent. White arsenic has been produced in Japan directly from ore and as a by-product of copper and lead smelting. The production direct from ore has been on a small scale since about 1910, and the by-product is the result of recent endeavors to prevent the escape of poisonous smelter fumes. It is understood that as much as 4,000 tons of (crude?) arsenious oxide per annum can be produced from the known sources if the demand is sufficient.

The two principal producers of arsenious oxide direct from ores are the Nippon Ahisan Kogyo Kabushiki Kaisha (Japan Arsenious

[28] Kehl, J. E., Mineral deposits and industries, Breslau, Germany, Apr. 20, 1922 (U. S. Geol. Survey Cons. file, No. 4163).

[29] Lindgren, Waldemar, Mineral deposits, pp. 696–697, 1913.

[30] Goodier, H. T. (American vice consul, Yokohama), report, Sept. 24, 1920 (U. S. Geol. Survey Cons. file, No. 1748).

Acid Manufacturing Co. (Ltd.)) and the Kyushu Ahisan Kogyo Kabushiki Kaisha. It is stated that one furnace operated by the first-named company has a capacity of about 3,333 pounds at a firing and that the charge is renewed about 20 times each month. The percentage of recovery of crude arsenic is not stated. Loss in refining is said to be about 20 per cent.

The principal producers of by-product arsenic are the Furukawa Kogyo Kabushiki Kaisha and the Mitsu Kozan Kabushiki Kaisha.

Only a small proportion of the output is used in Japan, in medicines, insecticides, and wall-paper coloring, and the greater part is exported to the United States, Great Britain, Australia, and the Philippines. No itemized records of exports are available, and no imports into Japan have been reported.

No arsenious oxide can be exported unless a certificate of analysis by a public chemical laboratory is attached to the documents for each shipment. An analysis made by the Ashio mine laboratory for crude arsenious oxide produced by the Furukawa company is as follows:

*Analysis of crude arsenious oxide from the Furukawa Co., Japan.*

| | |
|---|---|
| Arsenic ($As_2O_3$) by distillation | 96.79 |
| Iron oxide | .39 |
| Sulphur anhydride | 1.11 |
| Zinc | .21 |
| Lead | .26 |
| Antimony | .04 |
| Selenium and tellurium | .03 |
| Moisture | .40 |
| Other | .77 |
| | 100.00 |

According to an unofficial estimate [31] Japan's estimated production of crude and refined white arsenic in 1922 was somewhat greater than in 1921, but owing to the poor market in the United States the refined product was mostly exported to Europe. A further increase in production is expected in 1923 owing to good demands in both the United States and Europe.

One of the largest producers in 1922 and 1923 is the Hori Mining Co. (Ltd.), in Shimane Prefecture.

## OTHER COUNTRIES.

### WEST INDIES.

*Cuba.*—Extensive exploration in the Isle of Pines is said to have developed about 3,000,000 tons of gold-silver ore valued at $5 a ton, which also contains about 5 per cent of arsenic and 5 per cent of antimony. The vein is said to crop out for more than 8,000 feet and to have an average width of 45 feet.[32]

### SOUTH AMERICA.

*Argentina.*[33]—Arsenic and arsenic compounds are used in the glass factories of Argentina and for making insecticides, sprays, and colors. The market requirements in 1920 called for 99 per cent

[31] Written communication from M. Otagawa, of Furukawa & Co. (Ltd.).
[32] Eng. and Min. Jour.-Press, vol. 115, p. 132, Jan. 20, 1923.
[33] Commerce Repts., Nov. 18, 1920, p. 782.

arsenic, white, yellow, and red (arsenic disulphide), in barrels of 200 kilograms, and arsenate of lead and of soda in tins of 5 kilograms. The yearly demand for industrial arsenic is about 250 tons, although in 1919 the imports were more than twice this amount. First place as a source of supply now belongs to the United States.

*Brazil.*—At the reduction works of the Morro Velho gold mine,[34] in Brazil, 127 tons of white arsenic was produced in 1921 and the same quantity the previous year. Though this product is said to be very pure, the consumers of arsenic in Brazil have preferred imported material.

EUROPE.

*Greece.*—In Greece[35] there are no mines of arsenical ore, and white arsenic is obtained as a by-product of silver-lead ore, the source of which is not given.

*Jugoslavia.*[36]—The ores of arsenic have been recorded from numerous localities in Jugoslavia, but they have not hitherto been exploited on any extensive scale. According to Consul Wray,

> The most important arsenic mine is at Allchar, 55 kilometers east of Bitolje (Monastir), in Serbian Macedonia. The ores, which consist of orpiment and realgar (sulphides of arsenic), occur in association with antimony ores in Paleozoic limestones and dolomites. These mines yielded about 500 metric tons of arsenic annually prior to the Balkan and European wars. Practically the whole ore mined was picked over and sent in a raw condition to Salonika for transshipment to France.
>
> In northwestern Serbia realgar occurs in lead-bearing veins, hitherto unexploited, at Donja Tresnitsa, 7 kilometers south of Zvornik. It is also abundant at the old lead mines of Crnche, 11 kilometers south of Krupanj.
>
> In the old mining districts in the Kapoanik Mountains arsenical pyrites is recorded from numerous localities, the most important being those of Rudnjak, Gokchanitsa, and Chayetina, near Chackak.
>
> In northeastern Serbia arsenical pyrites is also recorded from Vrba, 30 kilometers north of Zayechar, and also from Vratarnitsa, 15 kilometers to the south of Zayechar. In both these localities it carries small percentages of gold and silver.
>
> The two most important localities in Bosnia are Srebrenik, 20 kilometers north of Donja Tuzla, in northeastern Bosnia, and Hrmsa, near Kresevo, in central Bosnia. In the former locality the ore consists of realgar or red arsenic sulphide, which occurs associated with dolomite, and smaller quantities of marcasite, in a vein about 2 meters thick. In the second area it occurs in a vein 3 meters wide in the form of realgar and orpiment associated with fluorspar. It here occurs in intimate association with intrusive masses of porphyry in the Triassic limestones.

*Portugal.*[37]—Seven mines in Portugal are producing arsenious ores. The production of arsenic has been small, but it is believed that assurance of a steady, attractive price would result in increased production. The most productive mine is the Minas de Pintor, in the district of Aveiro, belonging to the Anglo Peninsular Mining & Chemical Co. (Ltd.). This mine and its arsenic plant were described in 1918 as follows:[38]

> An interesting plant, from a metallurgical standpoint, is the arsenic smeltery in connection with the Pintor mines. The mines and smeltery are situated

[34] St. John Del Rey Mining Co. (Ltd.) Ninety-first Ann. Rept., for year ending Feb. 28, 1922.

[35] Lowrie, W. L. (American consul general, Athens), reports, Mar. 13 and Apr. 1, 1922 (U. S. Geol. Survey Cons. file, No. 4164).

[36] Wray, D. A., The geology and mineral resources of the Serb-Croat-Slovene State, 1921 (U. S. Geol. Survey Cons. file, No. 3–3151).

[37] Hollis, W. S. (American consul general, Lisbon), report, Mar. 9, 1922 (U. S. Geol. Survey Cons. file, No. 5489).

[38] Foote, F. W., and Ransom, R. S., jr., The mineral industry of Portugal: Eng. and Min. Jour., vol. 106, pp. 47–52, figs., sketch map, July 13, 1918.

about 30 kilometers south of Oporto and are operated by the Anglo Peninsular Mining & Chemical Co. (Ltd.), a subsidiary of the Wolfram Mining & Smelting Co. The ore occurs as arsenopyrite in veins in granite. The veins are mined to a depth of 100 meters, hydraulic and steam power being used. One reverberatory and one Oxland-type furnace are used, but the greater part of the ore is smelted in Pengilly furnaces designed by the manager, Albert Edward Pengilly, of which type there are 50 in operation. In 1914 the production was 803 tons of arsenic of a 95 per cent $As_2O_3$ purity.

*Spain.*—Arsenical ore is found along the coast in the vicinity of Valdovino, Monferoy, and Teijeiro, in Sobrado, Spain. From this ore white arsenic is produced. The mispickel deposits in the Valley of Ribas have been inactive.[39] The production of arsenical pyrites was 150 metric tons in 1919 and 1,000 tons in 1920. A discovery of arsenopyrite was reported[40] in the Province of Gerona near the French city of Le Perthus. A concession for the exploitation of these mines has been conceded in perpetuity to the Gascard Bros., of French nationality.

## AFRICA.

*Union of South Africa.*—Arsenopyrite is found in the gold and tin mines of South Africa, and it is reported[41] that many tons could be obtained if there were a demand. Large quantities of sodium arsenite are used annually for sheep and cattle dips, and the question of making these compounds in the country from materials produced locally is receiving attention. During 1918 two companies engaged in roasting tin ores produced 4 tons of white arsenic in condensing chambers erected for that purpose.

## ASIA.

*China.*—In China arsenic is a by-product of the ores of tin and antimony and is produced at the smelting plants of Changsha and Hankow.[42] For the most part the arsenic is consumed in China, although Hongkong imports a quantity which is afterward reexported to Indo-China. The arsenic is used principally for insecticides, Shantung Province consuming much of it in the control of worms. In 1921 Shanghai exported 1,656,000 pounds of arsenic, valued at $70,825.

From Hunan 333,916 pounds of white arsenic (native) and 27,193 pounds of realgar were exported in 1921.[43]

In the Province of Yunnan the Chinese have mined large quantities of orpiment, of which 5,000 to 10,000 hundred weight annually is carried by pack mules into Burma.[44]

The mines are situated at an elevation of 8,000 feet on the eastern edge of the Mehong drainage system, two days' journey to the southwest of Hsia-Kuan. The deposit appears to be confined to a band of grayish quartzite at least 4 feet thick, associated with soft black shales in the Red Beds series, of Permo-Triassic age. Small quantities of realgar and iron pyrites also occur. The arsenic sulphides form irregular strings, swelling out into patches and bands

[39] Busser, R. C. (American consul, Corunna), report, Apr. 28, 1922 (U. S. Geol. Survey Cons. file, No. 4193).
[40] Spencer, W. (chargé d'affaires, Madrid), report, Sept. 11, 1922 (U. S. Geol. Survey Cons. file, No. 4475).
[41] Pisar, C. J. (American vice consul, Cape Town), report, Mar. 8, 1922 (U. S. Geol. Survey Cons. file, No. 4201).
[42] Myers, M. C. (American consul, Swatow), report, Mar. 6, 1922 (U. S. Geol. Survey Cons. file, No. 4140).
[43] Burke, G. E. (clerk, American consulate, Changsha), report, June 29, 1922 (U. S. Geol. Survey Cons. file, No. 4140).
[44] Brown, J. C., Notes on antimony, arsenic, and bismuth: Bull. Indian Industries and Labor No. 6, p. 28, Calcutta, 1921.

of solid ore. All of the orpiment which is not absorbed in India is chiefly shipped to the Straits Settlements, and the market appears to be essentially an eastern one.

*India.*—India has not opened any important deposits of arsenic so far as known and imports white arsenic, of which 100 tons annually meets the demand. According to Brown,[45]

> Orpiment is the chief source from the mines of Chitral, but the output from them has fallen off considerably of late years. Orpiment and realgar also occur in scattered fragments on the moraines of the Shankalpa Glacier, in Kumaun, where they are collected and sold locally. Small veins in the Munsiari district of the same region are believed to furnish part of the supplies of the cities in northern India, for the mineral can be purchased in almost any bazaar. The future development of India's base-metal metallurgy may be a source of arsenic sometime.

*Turkey in Asia.*—The Turkish mines produced annually about 3,000 tons of orpiment, according to a published statement,[46] part of which follows:

> The orpiment is usually found associated with antimony. The mines at Elkhur, near Rozdan, produce 500 tons per annum. The ore is found in the same veins that carry the stibnite, but in pockets free from the presence of this last-named mineral. Most of the product is shipped by way of Salonica to France, a small proportion being reserved for home consumption. The mines near Yenikeny are important. They are noted for the excellent quality of their ores, which run as high as 42 per cent arsenic. Some gold is present. About 1,000 tons of this ore is shipped every year to Europe. Orpiment mines also exist at Togan-Hissar, near Dedeagatch, in the Province of Adrianople, and at Eyriden, in the Province of Salonica. Arsenical pyrite has, furthermore, been found in the Eudumish deposit.

### OCEANIA.

*Australia.*—At Jibbenbar, in Queensland,[47] the furnace of the State arsenic mine operated until the end of July, 1921, when the treatment of ore ceased in consequence of the overproduction of arsenic. The upper part of the Sundown mine, near Ballandean, on being investigated, proved to be much richer in arsenic than was expected. In the Yilgarn gold fields of Western Australia[48] there are several deposits of arsenical ore. Ore from the mine exploited by A. Leggo & Co., of Melbourne, Victoria, was shipped to Ballarat, but the freight costs were so high that shipments were stopped and the mine was closed.

## METHODS OF RECOVERING ARSENIC.

### WHITE ARSENIC.

At many of the deposits of gold ore mentioned in the preceding pages neither amalgamation nor table concentration has effected satisfactory recovery of the gold, except on the oxidized portions. The sulphide ore must be treated at the smelter, where the arsenic may be recovered as gray or crude arsenic and refined into white arsenic.

Many difficulties face the manufacturer of white arsenic, and those who contemplate building plants will be interested in the experimen-

[45] Brown, J. C., Notes on antimony, arsenic, and bismuth: Bull. Indian Industries and Labor No. 6, p. 28, Calcutta, 1921.
[46] Dominian, Leon, Mineral resources of the Turkish Empire: Min. and Sci. Press, vol. 98, pp. 821–826, sketch map, June 18, 1908.
[47] Under Sec. Mines Ann. Rept. for 1921, Brisbane, 1922.
[48] Balch, H. H. (American consul, Adelaide), Mineral deposits and industries of Western Australia, May 1, 1922 (U. S. Geol. Survey Cons. file, No. 4121).

tal work necessary to obtain a dense white product of arsenic free from antimony and lead as described by E. C. Williams.[49] In an article on the manufacture of arsenic trioxide George Vie[50] states that the arsenopyrite is crushed, concentrated, dried in a mechanical dryer, and then oxidized. The powdered state of the material allows some of the residue to go over with the arsenious oxide so that it must be resublimed. The oxide is caught in condensing chambers lined with sheet lead, and baffles of sheet lead impede the current of air. Water sprays are used in the chambers, which are very short. The oxide is then dried and is ready for shipment.

The Anaconda Copper Mining Co., at its concentrator near Anaconda, Mont., treats about 10,000 tons of copper ore daily. The concentrate from this ore contains about 1 per cent of arsenic, most of which accumulates as flue dust during smelting, but only about 25 per cent of the arsenic in the flue dust and fume is recovered as white arsenic. The output of refined white arsenic is 250 tons a month, according to the following notes.[51]

By successive distillation operations the Anaconda reduction works recovers white arsenic from flue dust and precipitated fume from the smelter flue system and Cottrell treaters.

The daily output of arsenical dust from the Cottrell treaters, depending on smelter operations, is from 40 to 100 tons, containing 20 to 30 per cent of $As_2O_3$, and is known as the "main-treater" dust.

The main-treater dust, mixed with a calculated quantity of flue dust and flux, is treated in a reverberatory furnace fired with pulverized coal. Sixty per cent of the total furnace charge of 250 to 300 tons is arsenical dust and yields a matte consisting of the metals from the dust. This matte is resmelted in the main reverberatory furnaces of the smelter.

Of the total arsenic contained in the material charged to the furnace, 26 per cent is lost in the slag, 3 per cent combines with the matte, and 3 per cent is unaccountably lost in dusting. The remaining arsenic leaves the furnace as fume, 3 per cent of it to water drainage, 2 per cent recovered eventually in the settling ponds and resmelted, 3 per cent lost out of the stack, 10 per cent in header flue and culverts (resmelted), and 9 per cent in connecting flues and recovered at flue clean-up period.

The remaining 43 per cent of the arsenic is removed daily from the hoppers of two Cottrell units, through which the furnace gas passes, known as the "hot" and "cold" treaters, which are connected with the system in series. A dust charge of 175 tons to the furnace yields daily about 25 tons of "crude arsenic" from the hot treater, containing 75 per cent of $As_2O_3$, while the cold treater turns out 7 tons averaging 85 per cent. This output of crude arsenic from the treaters depends on the temperature of the gases. The higher temperature permits less arsenic to precipitate in the first or hot treater and lowers, therefore, the tonnage removed from this unit, while the tonnage to the second or cold treater increases. A lower temperature increases the tonnage in the hot treater and decreases it in the cold treater. Water sprayed on the furnace gases reduces the temperature to a point which permits the condensation of arsenic. The water also prevents damage by warping in the treater construction.

The crude arsenic is first roasted in a McDougall reconstructed furnace, of which there are three units, each having a capacity of 30 tons of charge in 24 hours. These furnaces are undergoing an improvement by being fired with pulverized coal.

As it is impossible to rabble a charge of high arsenical content, owing to its stickiness just before it begins to volatilize, a proper amount of dust containing 15 per cent $As_2O_3$ is added to reduce the charge to less than 50 per cent $As_2O_3$. From the distilling furnace the arsenic fume passes through three condensing chambers connected in series. After the roasting of the crude arsenic, which

[49] Eng. and Min. Jour., Oct. 2, 1920, pp. 671–673.
[50] Chem. and Met. Eng., Mar. 23, 1921 (translation of an article in L'Industrie chimique, December, 1920).
[51] Wraith, C. R. (Anaconda Copper Mining Co.), personal communication, Mar. 15, 1923.

has undergone enrichment to 90 per cent or more of $As_2O_3$, it is discharged from the hoppers of the condensing chambers and transported to the refining plant. At this plant there are two small reverberatory refining furnaces in which high-grade coke is used as fuel, thus assuring a white arsenic product of high grade. Each of the two furnaces is charged daily with 20 tons of crude arsenic of the 90 per cent grade. A lower-grade material of 70 to 80 per cent $As_2O_3$ reduces the capacity of the furnaces 8 to 10 tons a day. From the refining furnaces the arsenic fumes pass through a series of condensing chambers of "zigzag" kitchens, where most of the arsenic is condensed, and then to a bag house. The bags catch the extremely fine fume from the condensing kitchens. Here the refined white arsenic is pulverized, barreled, and marketed.

The Toulon Arsenic Co. operates a plant at Toulon, 10 miles east of Lovelock, Pershing County, Nev., on the main line of the Southern Pacific Railroad from Ogden to San Francisco. This company owns a 150-ton wet-concentration mill, of which only the crushing department is in use. The ore is crushed in a jaw crusher and one set of rolls to about three-sixteenths of an inch and is roasted in a 7-hearth Wedge furnace 15 feet in diameter. From the furnace it goes to a dust catcher, from which the gas passes to a steel cooling and settling flue, and then to a second dust catcher before entering the fan and stack. The cooling and settling flue is of balloon cross section and is emptied by a screw conveyor. The refining section consists of a brick reverberatory furnace, coke fired, a steel cooling and settling flue, and a bag filter machine. The plant was built to make 15 tons of crude $As_2O_3$ daily, but in December, 1922, it had not reached that output, owing to a shortage of ore. The company controls the output of the Irish Rose mine, 9 miles south of Battle Mountain, which has an estimated reserve of 10,000 tons of ore containing 15 to 18 per cent of arsenic. From the Gem mine, in the Bullion district, which has an estimated reserve of 30,000 tons, the Toulon Co. gets a supply of 6 to 10 per cent arsenic ore containing some gold, silver, and copper. These and other ores are delivered by the Southern Pacific Railroad to Toulon. Some refined white arsenic and about 120 tons a month of crude material running over 94 per cent $As_2O_3$ is being shipped to consumers. The calcine containing gold, silver, and copper was sold to smelters.

## CALCIUM ARSENATE.

*Calcium arsenate from white arsenic.*—The purity and physical characteristics of white arsenic are important matters to the consumer, especially the manufacturer of calcium arsenate. The heavy granular white arsenic is preferred to the fluffy material for converting white arsenic to arsenic acid. According to some experiments, the solubility of white arsenic appears to vary directly with its specific gravity, and it has been suggested that the arsenic occurs in allotropic forms, one of which is comparatively insoluble in nitric acid. The insoluble variety has been converted into the soluble by a second refining. Fluffy material mixes slowly, but this is not as important as the variation in the purity of the product, which makes a difference of 5 to 27 hours for oxidizing. Some manufacturers who use white arsenic are more interested in its source and past history than in its total arsenic content. From laboratory experiments it is said that a 94 per cent grade of a certain make of white arsenic will oxidize in three seconds, while other makes of the same analysis, or even 99 per cent material, will take as long as 10 minutes. Antimony, bismuth, and selenium are not the only impurities in white

arsenic. At times a thousandth part of 1 per cent of mercury will retard oxidation.

The manufacture of calcium arsenate from arsenic acid is complicated, as is shown by the following brief article:

THE MANUFACTURE OF CALCIUM ARSENATE.[52]

By C. M. Smith,

Assistant chemist, insecticide and fungicide laboratory, miscellaneous division, Bureau of Chemistry, U. S. Dept. Agriculture.

The raw materials for the manufacture of calcium arsenate by the usual method are refined white arsenic and lime.

The refined white arsenic of commerce, containing approximately 99 per cent of arsenious oxide ($As_2O_3$), is first oxidized to arsenic acid, usually by means of nitric acid.[53] The arsenic acid produced in this manner is in the form of a solution containing approximately 60 per cent of arsenic oxide ($As_2O_5$). It is obtainable on the market in such form, but practically all the manufacturers of calcium arsenate find it more economical to maintain their own oxidizing plants.

The lime is used either as stone lime, requiring preliminary slaking, or as commercial hydrated lime. It should be as pure as possible; even the presence of carbonate is objectionable, for calcium arsenate does not react with arsenic acid to the desired degree.

It has been found by experiment that in order to obtain a product with sufficiently little water-soluble arsenic it is necessary to use approximately equal weights of calcium oxide (CaO) and arsenic oxide ($As_2O_5$). This results in a basic mixture containing lime in excess of the quantity required to form tricalcium arsenate $Ca_3(AsO_4)_2$. The requisite quantity of lime is made into a paste or suspension with water, and the arsenic acid is added while the mixture is constantly agitated. The dilutions used, the temperature, and the period of reaction vary among the different manufacturers; these factors influence the physical nature of the finished material very markedly.

The thin suspension of calcium arsenate, which is practically insoluble, is next filtered, most usually by means of ordinary filter presses. The filtered material, which may still contain 50 per cent or more of water, is then dried in any standard form of drier, usually steam heated. Drying without filtering has been tried by the use of a steam-heated drum revolving in a trough containing the calcium arsenate suspension, but such a method is not in favor at present. No washing of the product is necessary, as the only by-product of the reaction is water.

When thoroughly dry the calcium arsenate is ground in a suitable mill, one of the impact type being commonly used. It is finally packed for shipment, preferably in sheet-metal drums for the cotton-dusting trade; the 100-pound size is standard.

When shipped into interstate commerce calcium arsenate is subject to the provisions of the Federal insecticide act of 1910 and to certain rulings issued by the Insecticide and Fungicide Board of the Department of Agriculture. In addition to this, the Delta laboratory of the Bureau of Entomology, Department of Agriculture, has set up certain specifications for calcium arsenate intended for cotton dusting. These specifications require that the product must contain at least 40 per cent of total arsenic oxide and less than 0.75 per cent of water-soluble arsenic oxide and must have an apparent specific volume between 80 and 100 cubic inches to the pound.

The methods for the chemical analysis of this product are given in the Journal of the Association of Official Agricultural Chemists, volume 5, parts 1 and 3, and in "Official and tentative methods of analysis of the Association of Official Agricultural Chemists." The specific volume is to be determined in special apparatus developed by the Delta laboratory, from which details of its design may be obtained. This physical requirement is based on the fact that the dusting qualities have been found to be related to the bulk or fluffiness, and the limits were set to include the useful range. Granular material neither spreads nor sticks well, and extremely fine particles are carried too far by a breeze. The physical properties seem to be governed primarily by the conditions of the

[52] Abstract of an article of the same title which will soon be submitted for publication.

[53] The lower oxides of nitrogen resulting from this reaction are reoxidized by air and recovered by passing the brown fumes into coke-filled towers through which water is circulated. The nitric acid thus obtained is used over and over.

chemical reaction during manufacture, and not by grinding, as might be supposed.

In addition to the method of manufacture of calcium arsenate outlined above, by which practically all the calcium arsenate heretofore used has been made, there are several new methods being developed in response to the great demand caused by the ravages of the cotton-boll weevil. Of these, the one which is based on the use of a natural deposit of ferric arsenate (the mineral scorodite) has received the greatest notice and is now being operated on a commercial scale. In this process the arsenic does not have to be oxidized, for it is already present in the pentavalent form. Other methods using chlorine for the oxidation of arsenite to arsenate are being developed, but they have not yet assumed commercial importance.

*Calcium arsenate from scorodite.*—The Salt Lake Insecticide Co., at Salt Lake City, began in January, 1923, to manufacture calcium arsenate direct from ore, the principal arsenic mineral of which is scorodite, a hydrous ferric arsenate. As is common with new manufacturing plants, progress was slow at first while details of the process were being perfected, but the first car of calcium arsenate, routed for Georgia, was shipped in April, and the company is therefore in time to contribute to the late demands of the 1923 season.

The ore contains from 12 to 40 per cent of arsenic pentoxide and about 2 ounces of silver to the ton. The deposit is at Gold Hill, Utah, on a branch of the Western Pacific Railroad, and is probably the largest deposit of the kind in this country. The ore is crushed in rolls and ground with caustic soda solution in a ball mill. This mixture is further agitated in mixing tanks and filtered, after which the residue is washed. To the filtrate is added a calculated quantity of milk of lime, which precipitates basic calcium arsenate. The precipitate is filtered, washed, dried, and pulverized. The solution of regenerated caustic soda is concentrated and again used for leaching ore. The residue of the leached ore is sold to smelters for the recovery of silver and other metals.

## LEAD ARSENATE.

A bulletin on the composition of lead arsenates and methods of home manufacture was published by the Department of Agriculture in 1910.[54]

A mixture of the basic and acid arsenates of lead can be prepared electrolytically from disodium arsenate or arsenic acid.[55]

## ELEMENTAL ARSENIC.

A plant using the Hoskins process for the manufacture of elemental arsenic from white arsenic was operated near Chicago in 1920. The competition of a German product that sold for about 20 cents a pound prevented the operation of the plant in 1921 or 1922. The Hoskins plant as described [56] consisted of four furnaces in which metallic arsenic was made by reducing $As_2O_3$ with charcoal. The furnaces were heated by gas to temperatures between 1,200° and 1,300° F. The furnace charge ranged from 200 to 450 pounds, with the proportion of 1 pound of charcoal to 4 pounds of $As_2O_3$. The smaller charge was reduced in 7 hours and the larger one in 10 hours.

[54] Haywood, J. K., and McDonnell, C. C., Lead arsenate: U. S. Dept. Agr. Bur. Chemistry Bull. 131, p. 50, 1910.

[55] Tartar, H. V., and Grant, G. G., Jour. Ind. and Eng. Chemistry, vol. 101, p. 61, April 24, 1922.

[56] Jones, C. H., Pure metallic arsenic manufacture: Chem. and Met. Eng., vol. 23, pp. 957–960, Nov. 17, 1920.

# LEAD AND ZINC PIGMENTS AND SALTS.

By C. E. Siebenthal and A. Stoll.

## PRODUCTION.

Lead and zinc pigments and salts are made both by smelting and by chemical processes. Sublimed lead, or basic lead sulphate, and the various lead oxides are examples of lead pigments produced by sublimation in oxidizing furnaces; basic carbonate white lead and the lead salts are made by chemical processes. Sublimed lead, or basic lead sulphate, is made directly from ore, but the lead oxides as well as white lead and lead salts are made from pig lead.

Zinc oxide and leaded zinc oxide are made by the American process directly from ore by sublimation in an oxidizing furnace, but some zinc oxide is made in this country by the French process, in which metallic zinc is sublimated in an oxidizing furnace. Lithopone and zinc salts are made by chemical processes, the zinc base being derived from zinc ore, metallic zinc, galvanizers' ashes, or scrap zinc. Lithopone is made by mixing equivalent portions of solutions of zinc sulphate and barium sulphide, which brings about a mutual precipitation of zinc sulphide and barium sulphate either in chemical combination or as a very intimate mixture.

The increase in the quantity of lead and zinc pigments marketed in 1922 over that marketed in 1921 is indicative of an active year in the industry and also of some expansion. The Anaconda Copper Mining Co. began the construction of two zinc oxide plants, one at East Chicago, Ind., near the Anaconda Lead Products Co.'s electrolytic white lead plant, and the other at Akron, Ohio. These plants will make lead-free French process zinc oxide from Anaconda electrolytic zinc for the rubber trade.

The new plant of the American Zinc Oxide Co., of Columbus, Ohio, started operations early in 1921. An additional unit doubling the capacity was operated in 1922. Zinc sulphide ore from the mine at Mascot, Tenn., roasted at Hillsboro, Ill., is used. Roasting kilns of the Wedge type were installed at Columbus in 1922, and the sulphur gas produced is sold to an adjacent fertilizer plant. The lead-free zinc oxide is used in the rubber industry.

Marshall Evans, late of the Eagle-Picher Lead Co., is building a plant at Charleston, W. Va., under the name of the Evans Lead Co. Production in 1923 will be limited to litharge and red lead, but white lead also will be made later on.

*Lead pigments and salts marketed in 1921 and 1922.*

| | 1921 | | | 1922 | | |
|---|---|---|---|---|---|---|
| | Short tons. | Value. | | Short tons. | Value. | |
| | | Total. | Per ton. | | Total. | Per ton. |
| Sublimed lead, or basic lead sulphate: | | | | | | |
| White | 11,568 | $1,418,403 | $122.61 | 13,765 | $1,829,865 | $132.94 |
| Blue | 463 | 58,593 | 126.55 | 972 | 129,230 | 132.95 |
| Red lead | 21,805 | 3,414,452 | 156.59 | 30,509 | 5,104,290 | 167.30 |
| Orange mineral | 381 | 91,887 | 241.17 | 370 | 83,022 | 224.38 |
| Litharge | 41,909 | 5,735,824 | 136.86 | 58,261 | 8,892,172 | 152.63 |
| White lead: | | | | | | |
| Dry | 26,738 | 3,755,418 | 140.45 | 41,598 | 5,785,165 | 139.07 |
| In oil | 143,545 | 27,505,145 | 191.61 | 153,393 | 29,728,230 | 193.80 |
| Lead acetate | 2,092 | 552,435 | 264.07 | (a) | (a) | (a) |
| Lead arsenate | 5,733 | 2,090,341 | 364.62 | (a) | (a) | (a) |

a Statistics for lead arsenate and lead acetate collected biennially by the Bureau of the Census.

*Zinc pigments and salts marketed in 1921 and 1922.*

| | 1921 | | | 1922 | | |
|---|---|---|---|---|---|---|
| | Short tons. | Value. | | Short tons. | Value. | |
| | | Total. | Per ton. | | Total. | Per ton. |
| Zinc oxide | 74,329 | $11,231,716 | $151.11 | 128,465 | $17,994,704 | $140.07 |
| Leaded zinc oxide | 16,103 | 2,092,320 | 129.93 | 19,613 | 2,251,601 | 114.80 |
| Lithopone | 55,016 | 6,681,563 | 121.45 | 83,360 | 9,214,040 | 110.53 |
| Zinc chloride, 50° Baumé | 59,457 | 3,552,619 | 59.75 | 41,627 | 2,009,147 | 48.27 |
| Zinc sulphate | 3,295 | 189,369 | 57.47 | 5,078 | 251,528 | 49.53 |

## SOURCE.

*Metal content of lead and zinc pigments and salts, 1921 and 1922, by sources, in short tons.*

| Source. | 1921 | | | | 1922 | | | |
|---|---|---|---|---|---|---|---|---|
| | Lead. | | Zinc. | | Lead. | | Zinc. | |
| | Pigments.a | Salts. | Pigments. | Salts. | Pigments. | Salts. | Pigments. | Salts. |
| Domestic ore | 9,989 | ..... | 52,087 | 3,749 | 13,892 | (b) | 91,874 | 1,801 |
| Foreign ore | 169 | ..... | 1,393 | ..... | ..... | (b) | 1,238 | ..... |
| Metal | 200,599 | ..... | 7,465 | 528 | 241,096 | (b) | 16,298 | 1,041 |
| Secondary material c | ..... | ..... | 4,024 | 10,225 | 111 | (b) | 8,609 | 9,016 |
| | 210,757 | d 4,811 | 64,969 | 14,502 | 255,099 | (b) | 118,019 | 11,858 |

a Includes lead from zinc oxide and leaded zinc oxide.
b Statistics not collected in 1922.
c Zinc ashes, skimmings, drosses, and old metal.
d The source of the lead contained in lead salts is unknown to the Geological Survey. Lead acetate is made from litharge, from granulated lead, and from white lead residues. Lead arsenate is made from lead acetate or lead nitrate.

## IMPORTS AND EXPORTS.

The following statistics of imports and exports of lead and zinc pigments and salts have been compiled from the publications or records of the Bureau of Foreign and Domestic Commerce, Depart-

ment of Commerce, by J. A. Dorsey, of the United States Geological Survey.

*Basic carbonate white lead, red lead, litharge, and orange mineral imported and entered for consumption in the United States, 1917–1922.*

| Year. | Basic carbonate white lead. | | Red lead. | | Litharge. | | Orange mineral. | |
|---|---|---|---|---|---|---|---|---|
| | Pounds. | Value. | Pounds. | Value. | Pounds. | Value. | Pounds. | Value. |
| 1917 | 20,238 | $1,965 | 50 | $13 | ..... | ..... | 33,294 | $4,892 |
| 1918 | 508 | 202 | 5 | 1 | 100 | $12 | ..... | ..... |
| 1919 | 21,213 | 2,490 | 7,199 | 1,136 | ..... | ..... | 39,781 | 5,082 |
| 1920 | 159,977 | 19,449 | 23,076 | 1,789 | 21,002 | 2,647 | 52,094 | 5,352 |
| 1921 | 124,176 | 12,598 | 12,236 | 689 | 100 | 7 | 77,937 | 7,830 |
| 1922 | 222,465 | 21,335 | 1,405 | 94 | 1,770 | 162 | 111,419 | 9,729 |

*Zinc oxide, lithopone, zinc sulphide (white), zinc chloride, and zinc sulphate imported and entered for consumption in the United States, 1917–1922.*

| Year. | Zinc oxide. | | | | Lithopone. | |
|---|---|---|---|---|---|---|
| | Dry. | | In oil. | | Short tons. | Value. |
| | Short tons. | Value. | Short tons. | Value. | | |
| 1917 | 119 | $52,649 | 5 | $876 | 224 | $29,199 |
| 1918 | 162 | 62,703 | 4 | 1,043 | ..... | ..... |
| 1919 | 105 | 44,338 | 3 | 1,351 | 739 | 122,708 |
| 1920 | 1,431 | 289,890 | 14 | 3,596 | 1,714 | 263,240 |
| 1921 | 1,286 | 145,071 | 57 | 17,549 | 5,247 | 432,019 |
| 1922 | 2,712 | 361,599 | 42 | 8,595 | 10,263 | 885,671 |

| Year. | Zinc sulphide.[a] | | Zinc chloride. | | Zinc sulphate. | |
|---|---|---|---|---|---|---|
| | Pounds.[a] | Value. | Short tons. | Value. | Short tons. | Value. |
| 1917 | 9,990 | $6,519 | 2 | $403 | (b) | $57 |
| 1918 | 2,670 | 993 | 98 | 15,177 | ..... | ..... |
| 1919 | 10,035 | 4,413 | 1 | 192 | (b) | 152 |
| 1920 | 45,482 | 15,027 | 565 | 76,495 | 50 | 3,038 |
| 1921 | 93,537 | 8,330 | 2,199 | 213,995 | 17 | 820 |
| 1922 | 27,159 | 8,453 | 1,374 | 87,509 | 17 | 1,064 |

[a] Zinc sulphide is stated in pounds rather than tons because of its high value and smaller quantities.
[b] Less than 1 ton.

*White lead and red lead exported from the United States, 1917–1922.*

| | White lead. | | Red lead. | |
|---|---|---|---|---|
| | Short tons. | Value. | Short tons. | Value. |
| 1917 | 9,869 | $2,089,659 | [a] 1,086 | [a] $267,238 |
| 1918 | 7,704 | 1,756,739 | 2,870 | 662,584 |
| 1919 | 14,017 | 3,037,292 | 3,114 | 735,177 |
| 1920 | 14,901 | 3,195,101 | 1,532 | 365,575 |
| 1921 | 5,161 | 993,130 | 548 | 115,500 |
| 1922 | 4,598 | 710,765 | 1,633 | 294,133 |

[a] July 1–Dec. 31, inclusive. Not separately classified prior to July.

*White lead exported from the United States in 1921 and 1922.*

[Figures in parentheses not duplicated in totals.]

| Destination. | 1921 | | 1922 | |
|---|---|---|---|---|
| | Short tons. | Value. | Short tons. | Value. |
| Africa | 18 | $5,253 | 1 | $220 |
| Asia | 52 | 13,398 | 60 | 10,897 |
| Australia and Oceania | 226 | 50,817 | 165 | 33,644 |
| Australia | (16) | (3,299) | (9) | (1,566) |
| New Zealand | (21) | (4,697) | (1) | (375) |
| Philippine Islands | (182) | (41,042) | (141) | (28,348) |
| Canada | 129 | 20,105 | 53 | 8,386 |
| Cuba | 51 | 11,744 | 65 | 14,194 |
| Europe | 2,933 | 504,973 | 2,809 | 391,940 |
| Belgium | (622) | (105,209) | (938) | (127,275) |
| France | | | (56) | (7,821) |
| Great Britain | (1,568) | (273,105) | (1,377) | (193,679) |
| Netherlands | (732) | (124,988) | (417) | (59,749) |
| Mexico | 263 | 58,365 | 124 | 28,944 |
| Panama | 236 | 62,488 | 6 | 1,467 |
| South America | 1,139 | 240,143 | 1,199 | 196,110 |
| Brazil | (2) | (762) | (6) | (1,066) |
| Colombia | (14) | (3,100) | (22) | (4,251) |
| Uruguay | (109) | (26,366) | (83) | (12,923) |
| Venezuela | (7) | (1,913) | (9) | (2,014) |
| Other countries | 114 | 25,844 | 116 | 24,963 |
| | 5,161 | 993,130 | 4,598 | 710,765 |

*Zinc oxide exported from the United States, 1917–1922.*

| Year. | Short tons. | Value. |
|---|---|---|
| 1917 | 15,446 | $3,148,898 |
| 1918 | 12,421 | 2,779,507 |
| 1919 | 14,703 | 3,059,276 |
| 1920 | 11,164 | 2,151,544 |
| 1921 | 2,511 | 426,253 |
| 1922 | 3,977 | 593,128 |

*Zinc oxide exported from the United States in 1921 and 1922.*

[Figures in parentheses not duplicated in totals.]

| Destination. | 1921 | | 1922 | |
|---|---|---|---|---|
| | Short tons. | Value. | Short tons. | Value. |
| Asia | 18 | $5,486 | 4 | $1,113 |
| Australia and Oceania | 22 | 5,578 | 64 | 11,642 |
| Philippine Islands | (14) | (2,905) | (37) | (7,481) |
| Canada | 1,685 | 271,753 | 3,218 | 459,819 |
| Cuba | 24 | 7,066 | 33 | 7,583 |
| Europe | 480 | 70,617 | 381 | 53,634 |
| France | (251) | (37,511) | (70) | (10,214) |
| Great Britain | (150) | (21,798) | (300) | (41,770) |
| Italy | (79) | (11,263) | (11) | (1,650) |
| Sweden | (a) | (45) | | |
| Mexico | 150 | 34,698 | 109 | 23,193 |
| Panama | 12 | 2,905 | 2 | 539 |
| South America | 109 | 25,143 | 123 | 26,561 |
| Brazil | (9) | (2,527) | (14) | (2,869) |
| Other countries | 11 | 3,007 | 43 | 9,044 |
| | 2,511 | 426,253 | 3,977 | 593,128 |

a Less than 1 ton.

## CUSTOMS DUTIES.

In the following table are shown the tariff rates imposed on lead and zinc pigments and chemicals in the tariff acts of 1909, 1913, and 1922. As most of the rates levied on these commodities in the tariff of 1913 were ad valorem, for ease of comparison with the corresponding specific rates of the preceding and succeeding tariffs the average duty collected over the life of the tariff (October 3, 1913, to September 21, 1922) has been calculated and is given in another column after the ad valorem rates.

*Comparison of tariff imposts on lead and zinc pigments and chemicals in the acts of 1909, 1913, and 1922, in cents per pound.*

| | 1909 | 1913 | | 1922 |
|---|---|---|---|---|
| | | Rate. | Average collected. | |
| | *Cents.* | *Per cent.* | *Cents.* | *Cents.* |
| White lead | 2½ | 25 | 2 | 2½ |
| Red lead | 2⅝ | 25 | 3 | 2¾ |
| Orange mineral | 2½ | 25 | 2½ | 3 |
| Litharge | 2½ | 25 | 1⅝ | 2½ |
| Lead acetate: | | | | |
| White | 3 | ..... | 1¼ | 2½ |
| Brown, etc. | 2 | ..... | 1 | 2 |
| Lead arsenate | [a] 20% | [b] 20 | ..... | 3 |
| Zinc oxide: | | | | |
| Dry | [c] 1 | [d] 10 | ⅘ | [e] 1¾ |
| In oil | [c] 1¾ | [d] 15 | 1⅞ | [e] 2¼ |
| Leaded zinc oxide, dry | [f] 2½ | [g] 25 | ..... | [h] 2¼ |
| Zinc sulphide | 1¼ | 15 | 1 1/13 | 1½ |
| Lithopone | 1¼ | 15 | 1 5/16 | 1⅝ |
| Zinc chloride | 1 | ..... | ½ | 1 3/10 |
| Zinc sulphate | 1 | ..... | ½ | ¾ |

[a] As "manufactured article * * * not specially provided for." Statistics of imports not available.
[b] As "other lead compounds not specially provided for." Statistics of imports not available.
[c] Not containing lead.
[d] Not more than 5 per cent of lead.
[e] Not more than 25 per cent of lead.
[f] Containing lead.
[g] More than 5 per cent of lead; statistics of imports not available.
[h] More than 25 per cent of lead.

The tariff act of 1922 contains the following paragraphs relating to lead and zinc pigments and salts:

PAR. 47. Lead: Acetate, white, 2½ cents per pound; acetate, brown, gray, or yellow, 2 cents per pound; nitrate, arsenate, and resinate, 3 cents per pound; and all other lead compounds not specially provided for, 30 per centum ad valorem.

PAR. 74. Lead pigments: Litharge, 2½ cents per pound; orange mineral, 3 cents per pound; red lead, 2¾ cents per pound; white lead, 2½ cents per pound; all pigments containing lead, dry or in pulp, or ground in or mixed with oil or water, not specially provided for, 30 per centum ad valorem.

PAR. 79. Zinc oxide and leaded zinc oxides containing not more than 25 per centum of lead, in any form of dry powder, 1¾ cents per pound; ground in or mixed with oil or water, 2¼ cents per pound; lithopone, and other combinations or mixtures of zinc sulphide and barium sulphate, 1¾ cents per pound.

PAR. 93. Zinc chloride, 1 3/10 cents per pound; zinc sulphate, three-fourths of 1 cent per pound; and zinc sulphide, 1½ cents per pound.

## PRICES AND VALUE.

The total amount and the average per ton received for sales of each lead and zinc pigment and salt are given in the tables on page 78. Figure 6 shows the relation of the average weekly price of lead in New York to the weekly quotations on several pigments and salts of lead as given in the Oil, Paint, and Drug Reporter, and figure 7

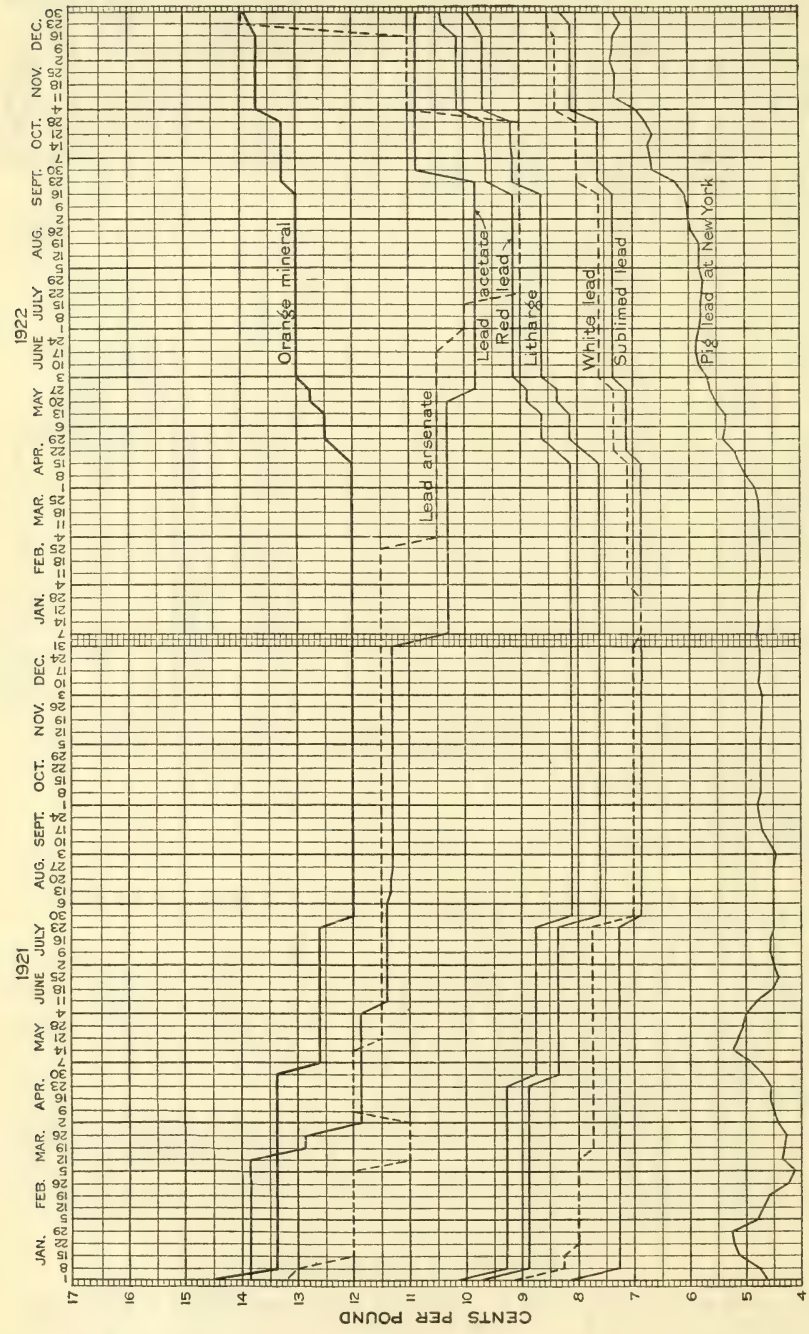


FIGURE 6.—Diagram showing relation of weekly prices of lead pigments and salts to the average weekly quoted price of lead at New York, 1921–22.

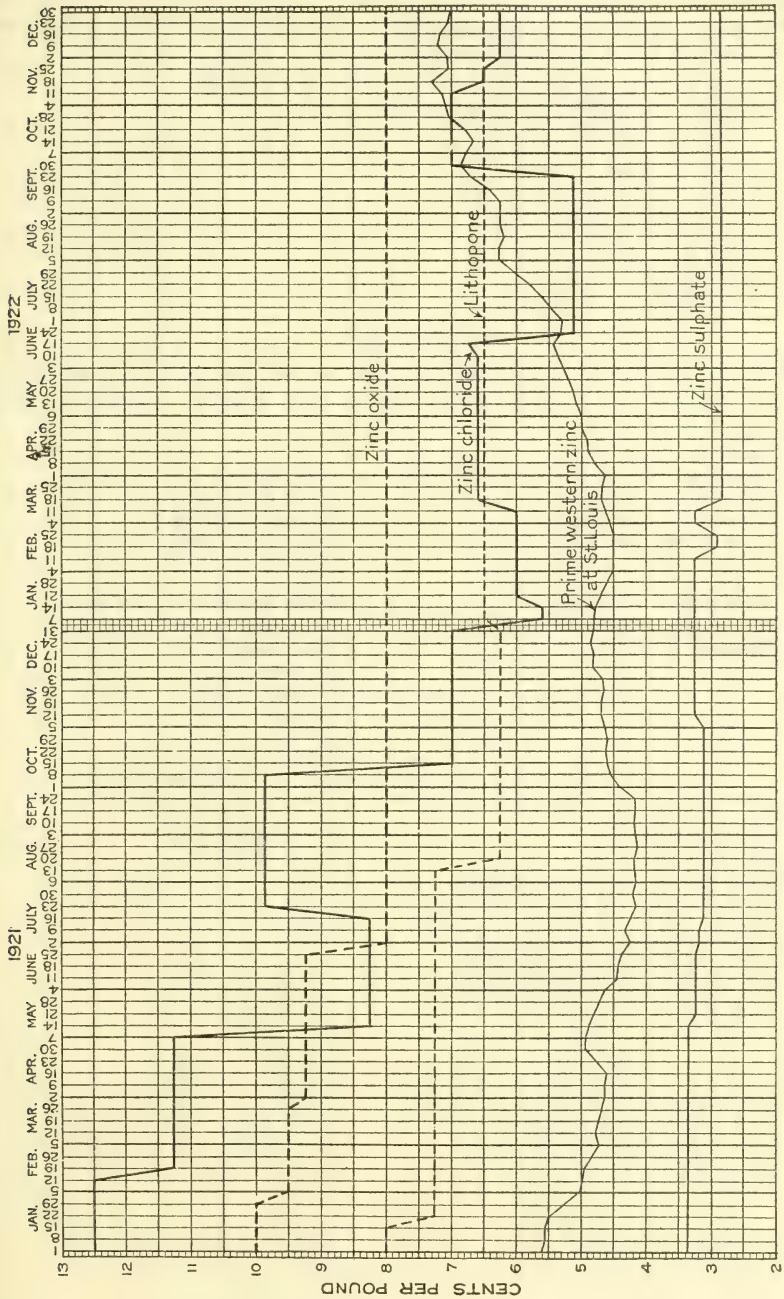


FIGURE 7.—Diagram showing relation of weekly prices of zinc pigments and salts to the average weekly quoted price of prime western zinc at St. Louis, 1921–22.

shows the relation of the weekly average quoted price of prime western slab zinc in St. Louis to the weekly quotations on certain pigments and salts of zinc, as given in the same journal. The qualities and conditions of the pigments and salts on which the prices were quoted are designated as follows:

Sublimed lead, or basic lead sulphate (white), "in casks."
White lead, "American, dry, in casks."
Litharge, "commercial, powdered, in casks."
Red lead, "dry, in casks."
Orange mineral, "American."
Lead acetate, "brown, broken."
Lead arsenate, "paste."
Zinc oxide, "commercially lead-free."
Lithopone, "in barrels."
Zinc chloride, "granulated."
Zinc sulphate, "industrial."

## PRODUCERS.

The producers of lead and zinc pigments and salts in 1922 are listed below, but the list includes some plants that did not operate in 1922.

| | |
|---|---|
| White lead: | |
| Anaconda Lead Products Co. (electrolytic process) | East Chicago, Ind. |
| Carter White Lead Co | South Chicago, Ill. |
| E. I. du Pont de Nemours & Co | Philadelphia, Pa. |
| Eagle-Picher Lead Co | Cincinnati, Ohio. |
| Do | East St. Louis, Ill. |
| Euston Process Co | Scranton, Pa. |
| W. P. Fuller & Co | South San Francisco, Calif. |
| John T. Lewis & Bros. Co | Philadelphia, Pa. |
| Matheson Lead Co | Long Island City, N. Y. |
| National Lead Co | Melrose, Calif. |
| Do | Chicago, Ill. |
| Do | St. Louis, Mo. |
| Do | Brooklyn, N. Y. |
| Do | Port Richmond, N. Y. |
| Do | Cincinnati, Ohio. |
| National Lead & Oil Co. of Pennsylvania | New Kensington, Pa. |
| Sherwin-Williams Co | Chicago, Ill. |
| United Lead Co | Perth Amboy, N. J. |
| Wetherill & Bro | Philadelphia, Pa. |
| Sublimed lead, or basic lead sulphate: | |
| Eagle-Picher Lead Co | Joplin, Mo. |
| St. Louis Smelting & Refining Works | Collinsville, Ill. |
| Red lead, orange mineral, and litharge: | |
| Chadwick-Boston Lead Co.[1] | Cambridge, Mass. |
| E. I. du Pont de Nemours & Co.[1] | Philadelphia, Pa. |
| Eagle-Picher Lead Co | Joplin, Mo. |
| Do | Newark, N. J. |
| Do | Cincinnati, Ohio. |
| Do | East St. Louis, Ill. |
| Evans Lead Co. (new) | Charleston, W. Va. |
| W. P. Fuller & Co | South San Francisco, Calif. |
| John T. Lewis & Bros. Co | Philadelphia, Pa. |
| Matheson Lead Co | Long Island City, N. Y. |
| National Lead Co | Melrose, Calif. |
| Do | Chicago, Ill. |
| Do | St. Louis, Mo. |
| Do | Brooklyn, N. Y. |
| National Lead & Oil Co. of Pennsylvania | New Kensington, Pa. |
| Pennsylvania Smelting Co | Carnegie, Pa. |
| Sherwin-Williams Co | Chicago, Ill. |
| Wetherill & Bro | Philadelphia, Pa. |

[1] No production in 1922.

| | |
|---|---|
| Zinc oxide and leaded zinc oxide: | |
| American Smelting & Refining Co.[1] | Omaha, Nebr. |
| American Steel & Wire Co.[1] | Donora, Pa. |
| American Zinc & Chemical Co | Langeloth, Pa. |
| American Zinc Co. of Illinois | Hillsboro, Ill. |
| American Zinc Oxide Co | Columbus, Ohio. |
| Anaconda Copper Mining Co. (new) | Akron, Ohio. |
| Do | East Chicago, Ind. |
| Bartlesville Zinc Co | Bartlesville, Okla. |
| Bertha Mineral Co.[1] | Austinville, Va. |
| Eagle-Picher Lead Co | Hillsboro, Ill. |
| Empire Zinc Co.[1] | Canon City, Colo. |
| Grasselli Chemical Co | Grasselli, Ind. |
| Grubnau Chemical Co., Inc | Waldo, N. Mex. |
| Mineral Point Zinc Co.[1] | Depue, Ill. |
| Do | Mineral Point, Wis. |
| New Jersey Zinc Co. of Pennsylvania | Palmerton, Pa. |
| Do. (French process.) | Freemansburg, Pa. |
| Ohio Zinc Co.[1] | Canon City, Colo. |
| Ozark Smelting & Mining Co | Coffeyville, Kans. |
| River Smelting & Refining Co | Florence, Colo. |
| Shasta Zinc & Copper Co | Winthrop, Calif. |
| Trenton Zinc & Chemical Co. (formerly M. M. S. Metal Co.) | Trenton, N. J. |
| U. S. Zinc Co | Pueblo, Colo. |
| Utah Zinc Co | Murray, Utah. |
| Western Zinc Oxide Co | Leadville, Colo. |
| Lithopone: | |
| Collinsville Zinc Corporation [1] | Collinsville, Ill. |
| Consolidated Chemical Products Co.[1] | Federal, Ill. |
| E. I. du Pont de Nemours & Co | Newark, N. J. |
| Do | Philadelphia, Pa. |
| Glidden Co | St. Helena, Md. |
| Grasselli Chemical Co | Grasselli, N. J. |
| Krebs Pigment & Chemical Co | Newport, Del. |
| Metals & Chemicals Extraction Corporation | Oakland, Calif. |
| Midland Chemical Co. (Eagle-Picher Lead Co.) | Argo, Ill. |
| Mineral Refining & Chemical Corporation | St. Louis, Mo. |
| New Jersey Zinc Co | Palmerton, Pa. |
| Sherwin-Williams Co | Chicago, Ill. |
| United Color & Pigment Co | Newark, N. J. |
| Zinc salts: | |
| American Zinc & Chemical Co | Langeloth, Pa. |
| Arkansas Preservative Co | Argenta, Ark. |
| By-Products Steel Corporation | Weirton, W. Va. |
| Consolidated Chemical Products Co.[1] | Federal, Ill. |
| Chas. Cooper & Co | Newark, N. J. |
| Delaware Hard Fibre Co | Wilmington, Del. |
| General Chemical Co | Chicago, Ill. |
| Grasselli Chemical Co | Grasselli, Ind. |
| Do | Grasselli, N. J. |
| Do | Cleveland, Ohio. |
| Great Western Electro-Chemical Co | San Francisco, Calif. |
| Charles Lennig & Co. (Inc.) | Philadelphia, Pa. |
| Merrimac Chemical Co | Everett, Mass. |
| Metals & Chemicals Extraction Corporation | Oakland, Calif. |
| Monsanto Chemical Works | East St. Louis, Ill. |
| New Jersey Zinc Co | Palmerton, Pa. |
| Newport Co | Milwaukee, Wis. |
| Pennsylvania Salt Manufacturing Co | Wyandotte, Mich. |

[1] No production in 1922.

# BAUXITE AND ALUMINUM.

By James M. Hill.

## BAUXITE.

### DOMESTIC PRODUCTION AND CONSUMPTION.

The bauxite industry of the United States showed marked improvement in 1922 over the conditions during 1921, owing to the increased demand for the products made from bauxite, particularly aluminum and aluminous abrasives. The domestic production of bauxite increased 122 per cent, as compared with 1921. In the Arkansas field the increase was approximately 114 per cent, but there is still opportunity for much larger production from this field. In the eastern field the increase was 191 per cent, showing the revival of the aluminum salts industry, as most of the bauxite from this field is used for the manufacture of alum and aluminum sulphate.

The figures for imports and exports in the following table have been compiled by J. A. Dorsey, of the United States Geological Survey, from records of the Bureau of Foreign and Domestic Commerce. The apparent consumption in the United States, as given in this table, is greater than the actual consumption, for the bauxite concentrates exported represent several times as much crude bauxite. Data from which to compute this difference are not available, but it is probably not very great.

*Bauxite produced and consumed in the United States, 1918–1922.*

| Year. | Domestic production. | | | | | |
|---|---|---|---|---|---|---|
| | Georgia, Alabama, and Tennessee. | | Arkansas. | | Total. | |
| | Long tons. | Value.[a] | Long tons. | Value.[a] | Long tons. | Value.[a] |
| 1918 | 42,829 | $314,112 | 562,892 | $3,133,880 | 605,721 | $3,447,992 |
| 1919 | 43,076 | 346,588 | 333,490 | 1,855,159 | 376,566 | 2,201,747 |
| 1920 | 40,029 | 349,453 | 481,279 | 2,897,892 | 521,308 | 3,247,345 |
| 1921 | 14,700 | 134,400 | 124,850 | 755,400 | 139,550 | 889,800 |
| 1922 | 42,810 | 329,440 | 266,790 | 1,682,890 | 309,600 | 2,012,330 |

| Year. | Imports. | | Exports.[b] | | Apparent domestic consumption. | |
|---|---|---|---|---|---|---|
| | Long tons. | Value. | Long tons. | Value. | Long tons. | Value. |
| 1918 | 3,653 | $14,791 | 19,711 | $1,523,688 | 589,663 | $1,939,095 |
| 1919 | 6,082 | 36,820 | 17,701 | 1,372,094 | 364,947 | 866,473 |
| 1920 | 42,895 | 251,284 | 22,257 | 1,843,596 | 541,946 | 1,655,033 |
| 1921 | 27,587 | 164,589 | 5,942 | 488,785 | 161,195 | 565,604 |
| 1922 | 23,656 | 93,805 | 19,617 | 961,208 | 313,639 | 1,144,927 |

[a] Value f. o. b. mines.

[b] Include bauxite concentrates.

In addition to the bauxite sold to various consumers, there was also sold to some of them in 1922 about 40,000 tons of diaspore clay, valued at approximately $3 a ton. Only a small portion of this high-alumina clay is used in the chemical industry, but about 90 per cent is used in the manufacture of alumina refractories.

A small quantity of alumina obtained as a by-product in the treatment of alunite for its potash content at Marysvale, Utah, was used for refractories.

Domestic bauxite was reported as sold to four consuming industries in 1922, as shown in the following table. The sales increased 131 per cent to the aluminum industry, 92 per cent to the aluminum chemical industry, and 181 per cent to the artificial abrasive industry. The last figure is of particular interest in that the consumption of abrasives follows the trend of the metal manufacturing and fabricating industries of the country.

*Domestic bauxite sold to various consuming industries, 1918–1922, in long tons.*

| Industry. | 1918 | 1919 | 1920 | 1921 | 1922 |
|---|---|---|---|---|---|
| Aluminum | 419,043 | 272,270 | 383,154 | 91,700 | 211,560 |
| Chemical | 63,896 | 67,842 | 85,878 | 41,000 | 78,540 |
| Abrasive | 112,908 | 35,395 | [a] 52,276 | 6,850 | 19,270 |
| Refractory | 9,874 | 1,059 | (a) | ..... | 230 |

[a] Small quantity sold to makers of refractories probably included under "Abrasive."

For the last few years it has been impossible to give separate statistics showing the value of either artificial aluminum abrasives or refractories. Some measure of the value of artificial abrasives made from bauxite may be had from the quantity of bauxite sold to that industry, as shown in the table above. In 1917 the abrasive industry consumed 110,000 long tons of bauxite and made artificial aluminum abrasives valued at $6,970,000, and in 1922 the consumption of bauxite by that industry was 18 per cent as great as in 1917.

*Value of aluminum and aluminum chemicals made from bauxite, 1918–1922.*

| Year. | New aluminum. | Aluminum chemicals. |
|---|---|---|
| 1918 | $41,159,000 | $8,047,700 |
| 1919 | 38,558,000 | 8,189,500 |
| 1920 | 41,375,000 | 9,968,200 |
| 1921 | 10,906,000 | 7,547,200 |
| 1922 | 13,622,000 | 8,813,000 |

## MARKET AND PRICES.

Bauxite finds its market east of Mississippi River and is sold largely to the manufacturers of aluminum, commercial chemicals, abrasives, and refractories. In the last few years some of the makers of refractories and aluminum chemicals have been using clay as a crude material, presumably mixed with bauxite in varying proportions. The clays used in place of bauxite are what might be termed "high-alumina clays," in that they carry larger quantities of alumi-

num oxide than kaolin. Most of such clays come from central Missouri, where diaspore-bearing clays carrying over 50 per cent of alumina are known to occur. These clays are now being marketed according to their alumina content, and three grades containing 55, 65, and 70 per cent of alumina ($Al_2O_3$) are regularly handled.

The largest consumers of bauxite in the United States are also producers, and there is only a small market for what might be called "outside bauxite." Consumers who do not own deposits contract for their supplies for considerable periods, apparently with the idea of assuring themselves of an adequate supply of bauxite of the grade desired. The price of bauxite at mines or shipping points in 1922, as reported by independent producers, ranged from $7.50 to $10 a ton; the average price reported by all producers for the year was $6.50 a ton f. o. b. mines. Consumers, on the other hand, report prices that average $14 a ton f. o. b. plants, a reduction of $1 a ton as compared with costs in 1921.

Bauxite is now regularly quoted in the Engineering and Mining Journal-Press. Crude bauxite was quoted at $8 to $10 a long ton during January and February and at $6 to $9 during the rest of the year. Dried and pulverized bauxite was quoted at $12 to $14 and calcined at $22 to $25 a ton f. o. b. shipping point. Foreign bauxite was offered at $5 to $8 c. i. f. American ports.

Under the tariff act of 1922 crude bauxite is dutiable at the rate of $1 a ton and alumina hydrate or refined bauxite at 1 cent a pound. (See par. 6, schedule 1, and par. 207, schedule 2.) Under the tariff of 1913 there was no import duty on bauxite, and the rate on alumina was 15 per cent ad valorem.

## WORLD'S PRODUCTION.

The following table was compiled by the section of foreign mineral reserves, United States Geological Survey, from official sources so far as possible.

*World's production of bauxite, 1913 and 1916–1921, by countries, in metric tons.*

| Country. | 1913 | 1916 | 1917 | 1918 | 1919 | 1920 | 1921 |
|---|---|---|---|---|---|---|---|
| Austria: | | | | | | | |
| Dalmatia | (a) | 83,837 | b134,781 | b94,500 | (a) | (c) | (c) |
| Istria | (a) | 58,489 | b28,341 | b70,100 | (a) | (d) | (d) |
| Lower Austria | (e) | (e) | (e) | (e) | (e) | 362 | 2,638 |
| British Guiana | | | 2,070 | 4,266 | 1,999 | 31,883 | 12,584 |
| British India | 1,203 | 762 | 1,385 | 1,211 | 1,709 | 3,995 | 4,728 |
| France | 309,294 | b106,170 | b120,883 | (a) | 159,103 | 266,700 | b 84,942 |
| Germany | (f) | (f) | 10,813 | 14,353 | 9,393 | 13,420 | (a) |
| Hungary | 1,792 | (a) | b128,651 | (a) | (a) | (a) | (a) |
| Italy | 6,952 | 8,887 | 7,789 | 7,800 | 2,972 | d13,139 | d 49,100 |
| Jugoslavia: Dalmatia | (g) | (g) | (g) | (g) | (g) | 27,860 | h 51,000 |
| Spain | | | | 460 | 1,780 | 540 | 184 |
| United Kingdom | 6,152 | 10,495 | 14,960 | 9,743 | 9,369 | 11,197 | 2,305 |
| United States | 213,615 | 431,923 | 577,817 | 615,443 | 382,610 | 529,675 | 141,790 |

a Data not available.
b Unofficial figures.
c Now included under Jugoslavia.
d Istria included under Italy.
e No record of any production prior to 1920, when one mine was operated.
f Prior to 1917 no separate figures of bauxite production available.
g See Austria.
h Exports; unofficial.

## BAUXITE DEPOSITS.

A general account of the bauxite deposits in the United States, specifications for bauxite, and much information concerning the industry has been given in a recent paper by Ladoo.[1]

Users of aluminous ores should be informed that diaspore in fairly pure crystalline form is found in some places in sufficient quantities to be of commercial interest. It is believed that this material could be used for abrasives and refractories and could probably also be treated for the manufacture of aluminum chemicals. Kyanite, sillimanite, and andalusite, aluminum silicates carrying more than 60 per cent of alumina, could possibly also be used for some of the purposes to which bauxite and diasporite clays are now being put. Kyanite is possibly the most readily available, and large deposits of it have been reported from Wyoming and Arizona.

*Alabama.*—The Republic Mining & Manufacturing Co. continued operations at Rock Run, Ala., in 1922, and was the only bauxite producer in the State. The E. I. du Pont de Nemours Co. has permanently abandoned the mining of bauxite in Alabama and elsewhere and in the future will purchase bauxite needed for its works at Philadelphia.

*Arkansas.*—At Bauxite, Saline County, Ark., the American Bauxite Co. increased its operations considerably, as compared with 1921, but did not attain its maximum production. The Southern Bauxite Co. opened a bauxite deposit adjoining the American Bauxite Co.'s property and made some shipments. In Pulaski County the Republic Mining & Manufacturing Co. and Globe Bauxite Co. continued operations. All the bauxite produced in Arkansas was dried before shipment, and most of it was used for the manufacture of aluminum. The Arkansas Legislature in 1923 passed a law that imposes a tax of 25 cents a long ton on all bauxite mined in the State.

*Georgia.*—Bauxite was produced in six counties in Georgia during 1922. Mines in Sumter County produced the greatest amount, followed in order of production by Macon, Floyd, Wilkinson, Bartow, and Halls. About 85 per cent of the bauxite mined in Georgia was sold dried and 15 per cent crude; practically 95 per cent went to makers of aluminum chemicals. The largest producer of bauxite in the State was the Republic Mining & Manufacturing Co., the Kalbfleisch Corporation was second, the Ideal Bauxite Co. and Hebble Estate were about equal for third place, and the Warner Bauxite Co. was fourth. It is reported that the Republic Mining & Manufacturing Co. has discontinued operations at the Sweetwater mine, near Andersonville, owing to the cost of removing the heavy overburden of sand from the bauxite bed.

It is understood that a detailed study of the clay and bauxite deposits tributary to the Central of Georgia Railway was made by T. Poole Maynard, geologist of the company, in cooperation with the United States Bureau of Mines. The results of this investigation are to be made public in a series of papers to be published in the Journal of the American Ceramic Society.

Recent reports that the Ford interests have purchased several bauxite deposits in Georgia are not correct.[2]

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[1] Ladoo, R. B., Bauxite—occurrence, mining, and uses: Eng. and Min. Jour.-Press, vol. 114, pp. 805–808, 1922.

[2] Letter from Henry Ford.

*Mississippi.*—So far no bauxite has been shipped from the deposits in Tippah, Benton, Union, and Pontotoc counties, Miss. It is said that the best deposits are in Pontotoc County. The Mississippi Bauxite Co. estimates that it controls a considerable quantity of merchantable ore.

*Missouri.*—The diaspore deposits of Gasconade and Maries counties, of central Missouri, continue to supply a clay sufficiently high in alumina to compete with bauxite for the manufacture of aluminous refractories and, to some extent, for the manufacture of aluminum salts and abrasives. The principal producers are the American Refractories Co., Evens & Howard Fire Brick Co., H. H. Heck Clay Co., and Laclede-Christy Clay Products Co.

Howe and Ferguson[3] have recently published the results of some research work on the use of diaspore for refractories, and Wysor[4] has given a description of the high-alumina clay deposits of this region.

*Tennessee.*—The Kalbfleisch Corporation and White, McAllister & Keiser operated bauxite mines on Missionary Ridge near Chattanooga, Tenn.

*Utah.*—It seems probable that the alumina by-product from the potash plants in the vicinity of Marysvale, Utah, may soon compete with bauxite for both chemical and refractory use. An article by Tingley[5] describes the experiments carried on by the Mineral Products Co. and the Florence Mining & Manufacturing Co. with alunite from their extensive holdings in the Tushar Mountains. It is known that some of the alumina by-product made by the former company is now being used as a refractory. Alunite deposits are known to occur in various parts of the United States and may in the future be the basis of industries in areas where bauxite would not be readily obtainable.

## ALUMINUM.

### DOMESTIC PRODUCTION AND CONSUMPTION.

The value of new aluminum produced in the United States in 1922 was approximately 25 per cent greater than in 1921 but only a quarter as great as the peak value in 1917. The value of secondary aluminum produced in 1922 increased 61 per cent over the value in 1921. Imports were valued at about $800,000 more in 1922, and exports were about $270,000 less. The value of aluminum apparently consumed in the United States in 1922 was 30 per cent greater than that in 1921 and reflects the general business revival, particularly the revival of the automobile industry and the resumption of use of aluminum in the transmission of electrical energy.

Secondary aluminum was recovered in 1922, according to statistics collected by J. P. Dunlop, of the United States Geological Survey, to the amount of 7,190 short tons as metal and 9,100 short tons as the aluminum content of various casting alloys. The total recovery was 16,290 short tons.

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[3] Howe, R. M., and Ferguson, R. F., Composition and properties of diaspore, bauxite, and gibbsite: Am. Ceramic Soc. Jour., vol. 6, p. 496, March, 1923 (abstract of article in Chem. and Met. Eng., vol. 28, p. 603, 1923).

[4] Wysor, D. C., Diaspore clay of Arkansas and Missouri: Am. Ceramic Soc. Jour., vol. 6, p. 501, March, 1923.

[5] Tingley, R. H., Alunite and its products; Eng. and Min. Jour.-Press, vol. 115, p. 494, 1923.

*Value of aluminum produced and consumed in the United States, 1918–1922.*

| Year. | Domestic production.[a] | | Imports.[b] | Exports.[c] | Apparent consumption. |
|---|---|---|---|---|---|
| | Primary metal. | Secondary metal. | | | |
| 1918 | $41,159,000 | $10,113,600 | $554,586 | $10,869,388 | $40,957,800 |
| 1919 | 38,558,000 | 12,014,600 | 4,568,595 | 3,890,326 | 51,250,900 |
| 1920 | 41,375,000 | 9,489,100 | 13,077,022 | 5,630,781 | 58,310,300 |
| 1921 | 10,906,000 | 3,775,400 | 8,889,791 | 3,108,857 | 20,462,300 |
| 1922 | 13,622,000 | 6,085,900 | 9,695,012 | 2,836,116 | 26,566,800 |

[a] Value of primary metal based on average open-market price at New York for small lots, as quoted by the Engineering and Mining Journal-Press, and that of secondary aluminum based on average price at New York as given by American Metal Market.
[b] Imports for consumption include aluminum in crude form, scrap, bars, strips, rods, plates, sheets, and all manufactures of.
[c] Exports include ingots, metal and alloy, plates and sheets, and all other manufactures of.

The following tables show the forms in which the bulk of our aluminum imports and exports are made. In 1922 the bulk of the imported aluminum was in crude or semicrude form, and the exports were about equally divided between finished products and ingots and rolled forms. These tables were compiled from the records of the Department of Commerce by J. A. Dorsey, of the United States Geological Survey.

*Aluminum imported for consumption in the United States in 1921–22, by classes.*

| Class. | 1921 | | 1922 | |
|---|---|---|---|---|
| | Pounds. | Value. | Pounds. | Value. |
| Crude form, scrap, alloy, etc. | 30,152,260 | $6,832,608 | 41,730,990 | $7,744,019 |
| Bars, strips, and rods | 397,871 | 115,030 | 426,364 | 118,617 |
| Plates and sheets | 2,008,878 | 678,801 | 1,723,993 | 421,616 |
| Wire and manufactures [a] of wire | 8 | 1,069 | 11,241 | 3,092 |
| Total crude and semicrude | 32,559,017 | 7,627,508 | 43,892,588 | 8,287,344 |
| Leaf | (b) | 21,115 | (b) | 17,841 |
| Table, kitchen, hospital utensils, etc. | ..... | 672,239 | ..... | 760,693 |
| All other manufactures | ..... | 568,929 | ..... | 629,134 |
| Grand total | ..... | 8,889,791 | ..... | 9,695,012 |

[a] Contains wire valued at $1,065 in 1921 and $19 in 1922, quantity not given.
[b] 1921, 10,629,300 leaves; 1922, 30,493,800 leaves. Equivalent weight not recorded.

*Domestic aluminum exported from the United States, 1921–22.*

| Class. | 1921 | | 1922 | |
|---|---|---|---|---|
| | Pounds. | Value. | Pounds. | Value. |
| Ingot, scrap, and alloy | 1,051,833 | $301,951 | 1,538,079 | $290,558 |
| Plates, sheets, bars, strips, and rods | 1,144,545 | 499,124 | 2,808,941 | 836,902 |
| Tubes, moldings, castings, and other shapes | (a) | 2,307,782 | 353,847 | 91,086 |
| Table, kitchen, and hospital utensils | | | 1,255,743 | 692,314 |
| Other manufactures | | | 2,935,359 | 925,256 |
| | (a) | 3,108,857 | 8,891,969 | 2,836,116 |

[a] Figures not available.

## MARKET AND PRICES.

Quotations on virgin aluminum, as given by the Engineering and Mining Journal-Press during 1922, were steady at 20 cents a pound for the 99 per cent grade, 19 cents for the 98 per cent grade, and 18 cents for the 94–98 per cent grade until August, when an advance of 0.1 cent a pound was recorded in the two higher grades. In November the quotations were raised to 21 cents, and they have continued to advance since then. Foreign aluminum was quoted at 2 or 3 cents less than domestic new aluminum, and secondary aluminum was sold at approximately the same price, the average for the year being 18.68 cents a pound.

In the tariff act of 1922 the following paragraphs, quoted from schedule 3, metals and manufactures, are of interest to all producers and consumers of aluminum:

PAR. 339. Table, household, kitchen, and hospital utensils, and hollow or flat ware, not specially provided for; composed of iron or steel and enameled or glazed with vitreous glasses, 5 cents per pound and 30 per centum ad valorem; composed wholly or in chief value of aluminum, 11 cents per pound and 55 per centum ad valorem; composed wholly or in chief value of copper, brass, steel, or other base metal, not specially provided for, 40 per centum ad valorem; and in addition thereto, upon any of the foregoing articles containing electrical heating elements as constituent parts thereof, 10 per centum ad valorem.

PAR. 374. Aluminum, aluminum scrap, and alloys of any kind in which aluminum is the component material of chief value, in crude form, 5 cents per pound; in coils, plates, sheets, bars, rods, circles, disks, blanks, strips, rectangles, and squares, 9 cents per pound.

PAR. 382. Aluminum or tin foil less than six one-thousandths of an inch in thickness, 35 per centum ad valorem; bronze powder, 14 cents per pound; aluminum powder, powdered foil, powdered tin, brocades, flitters, and metallics, manufactured in whole or in part, 12 cents per pound; bronze, or Dutch metal, or aluminum, in leaf, 6 cents per one hundred leaves. The foregoing rate applies to leaf not exceeding in size the equivalent of five and one-half by five and one-half inches; additional duties in the same proportion shall be assessed on leaf exceeding in size said equivalent.

Cryolite used in the manufacture of aluminum remains on the free list.

## ALUMINUM INDUSTRY.

The domestic plants increased their output in response to the increased demand of automobile manufacturers, many of whom have apparently adopted the aluminum alloy engine, piston, and connecting rod as standard. The demand for closed cars has resulted in an increased use of molded shapes. Both aluminum bronze powder and foil are reported to be in better demand. Early in 1923 it was announced that the Aluminum Co. of America had completed negotiations for giving financial assistance to the Norsk Aluminum Co.

A large amount of research work has been done during the year on various aluminum-copper and aluminum-silicon alloys. The technical press, particularly Chemical and Metallurgical Engineering, Metal Industry, and bulletins of the American Institute of Mining and Metallurgical Engineers, the Bureau of Standards, and the Bureau of Mines, contain many papers on this subject. An interesting new use of aluminum is in the preparation of calorized metals, which are said to be extremely resistant to corrosion, developed by the research department of the General Electric Co

## ALUMINUM SALTS.

### DOMESTIC PRODUCTION AND CONSUMPTION.

During 1922 manufacturers of aluminum salts consumed 162,976 long tons of bauxite, having an average value of $14 a ton at the plants, and 11,428 tons of high-alumina clay, as compared with 64,380 tons of bauxite and 9,830 tons of clay in 1921. These figures do not include the bauxite made into alumina as a preliminary step in the manufacture of aluminum.

As shown in the following table, the production of all aluminum salts, except aluminum chloride, increased materially in 1922, as compared with 1921.

*Aluminum salts produced in the United States, 1921–22*

| | 1921 | | 1922 | | | |
|---|---|---|---|---|---|---|
| | Short tons. | Value. | Number of producers reporting. | Short tons. | Value. | |
| | | | | | Total. | Average. |
| Ammonia alum | 6,284 | $434,248 | 6 | 8,305 | $535,759 | $65 |
| Sodium alum | (a) | (a) | 3 | 9,506 | 570,372 | 60 |
| Aluminum chloride | 5,646 | 551,874 | 5 | 4,039 | 289,502 | 72 |
| Aluminum sulphate: | | | | | | |
| Commercial— | | | | | | |
| General | 151,859 | 5,472,236 | 19 | 231,387 | 6,090,166 | 26 |
| Municipal | 3,060 | 53,839 | 9 | 6,075 | 126,095 | ..... |
| Iron-free | 11,003 | 592,216 | 7 | 19,162 | 968,645 | 51 |
| Other aluminum salts [b] | 6,961 | 442,771 | 14 | 3,006 | 232,448 | ..... |
| | [c] 184,813 | [c] 7,547,184 | ..... | 281,480 | 8,812,987 | ..... |

[a] Included under "Other aluminum salts."
[b] Includes potash alum (1 producer) and alumina, calcined and hydrated (2 producers).
[c] Revised figures.

### ALUMINUM SALTS INDUSTRY.

It is rumored that one of the companies treating alunite near Marysvale, Utah, and the Stauffer Chemical Co., at Stege, Calif., will begin the manufacture of aluminum sulphate during 1923.

The Bureau of Mines has recently published a paper by Ralston [6] on the manufacture and uses of aluminum chloride, in which he brings out the fact that with cheap aluminum chloride the potential demand for this chemical by the petroleum refining industry is 1,000,000 tons a year. The various processes of manufacture are given in outline, and the suggestion is made that aluminum silicates could probably be used as raw materials.

In the chapter on bauxite and aluminum in Mineral Resources for 1921 brief mention was made of the experiments on the use of aluminum sulphate for the treatment of impermeable soils, which have been carried out under the direction of Dr. C. S. Scofield,[7] of the United States Department of Agriculture. These experiments indicate that

[6] Ralston, O. C., Aluminum chloride, its manufacture and uses: Bur. Mines Tech. Paper 321, 1923.
[7] Scofield, C. S., Quality of irrigation water in relation to land reclassification: Jour. Agr. Research, vol. 21, pp. 265–278, May 16, 1921; The cause of hard lands: Recl. Record, vol. 12, pp. 520–522, November, 1921; Report on experimental investigations of the use of aluminum sulphate on alkali land on Reclamation Service stations: Recl. Record, vol. 13, pp. 4–5, January, 1922; The effect of alum on silicate colloids: Washington Acad. Sci. Jour., vol. 11, p. 438, Nov. 4, 1921.

soil impermeability is due to the formation of gelatinous silicates, chiefly sodium silicates rather than "black alkali," and that this soil condition can be remedied by treatment with alum or aluminum sulphate. Treatment with 2 tons to the acre has been shown by experiments to be beneficial, but some soils may require treatment with as much as 10 tons to the acre. Natural alum, such as the magnesium-aluminum sulphate, pickeringite, that is found in several places in the Western States, has been successfully used.

The apparent consumption of aluminum salts in the United States in 1922 is shown below. The imports have not been shown in detail under previous tariff acts, though the tariff of 1922 mentions several classes of aluminum chemicals, and the only salt exported is aluminum sulphate.

*Aluminum salts consumed in the United States, 1918–1922.*

| Year. | Domestic production. | | Imports. | | Exports.[a] | | Apparent consumption. | |
|---|---|---|---|---|---|---|---|---|
| | Short tons. | Value. | Short tons. | Value. | Short tons. | Value. | Short tons. | Value. |
| 1918 | 230,505 | $8,047,707 | 231 | $18,519 | (a) | (a) | 230,736 | $8,066,226 |
| 1919 | 223,547 | 8,189,519 | 343 | 21,877 | (a) | (a) | 223,890 | 8,211,396 |
| 1920 | 258,009 | 9,968,174 | 1,340 | 69,896 | (a) | (a) | 259,349 | 10,038,070 |
| 1921 | [b] 184,813 | [b] 7,547,184 | 1,009 | 45,963 | (a) | (a) | 185,822 | 7,593,147 |
| 1922 | 281,480 | 8,812,987 | 2,889 | 116,971 | 13,225 | $388,447 | 271,144 | 8,541,511 |

[a] Figures not separately shown prior to 1922. Figures for 1922 represent aluminum sulphate only.
[b] Revised figures.

The Geological Survey attempted to collect and publish more detailed figures of consumption of aluminum salts for 1922. Circulars were sent to all the commercial producers to ascertain their wishes, but the results of this canvass showed that the great majority of producers of aluminum salts did not wish more detailed statistical information concerning the industrial and regional consumption of their products.

## TARIFF.

Under the tariff act of 1922 several aluminum salts not covered under the tariff of 1913 are subject to special rates of duty. Under the tariff of 1913 all aluminum salts were dutiable at 15 per cent ad valorem. Paragraph 6 of schedule 1, chemicals, in the act of 1922 is of particular interest to producers and consumers of aluminum chemicals.

PAR. 6. Aluminum hydroxide or refined bauxite, one-half of 1 cent per pound; potassium aluminum sulphate or potash alum and ammonium aluminum sulphate or ammonia alum, three-fourths of 1 cent per pound; aluminum sulphate, alum cake, or aluminous cake, containing not more than 15 per centum of alumina and more iron than the equivalent of one-tenth of 1 per centum of ferric oxide, three-tenths of 1 cent per pound; containing more than 15 per centum of alumina or not more iron than the equivalent of one-tenth of 1 per centum of ferric oxide, three-eighths of 1 cent per pound; all other aluminum salts and compounds not specially provided for, 25 per centum ad valorem.

## ALUMINOUS REFRACTORIES.

Bauxite refractories or high-alumina refractories are finding wider markets, and some new producers entered this field in 1922. The Geological Survey has not been able to interest the producers of refractory aluminous products sufficiently to obtain accurate and complete statistics of the industry. That this industry is expanding is shown by the growing demand for bauxite and high-alumina clays by ceramists all over the country. In 1922 the makers of refractory brick took 230 tons of bauxite and 36,990 tons of high-alumina clay. Kyanite, sillimanite, and andalusite as possible new sources of aluminous raw materials are mentioned on page 90. That sillimanite itself may be used as a refractory has been indicated.[8] Considerable discussion of aluminous abrasives took place at the twenty-fifth meeting of the American Ceramic Society recently held in Cleveland.[9]

Aluminous refractory brick are sold in various shapes, the alumina content of which ranges from 50 to 76 per cent.

## BAUXITE ABRASIVES.

During 1922 makers of artificial aluminous abrasives purchased 19,270 tons of bauxite, as compared with 6,850 tons in 1921. It is therefore evident that the industry was in much better shape than during the depression. Detailed statistics of production of aluminous artificial abrasives for recent years are not available for publication, but they are combined with figures of output of silicon carbide abrasives in the chapter on abrasive materials. Under the tariff of 1922 artificial abrasives in ground form are dutiable at 1 cent a pound and in manufactured form at 20 per cent ad valorem. Emery, corundum, and crude artificial abrasives are on the free list.

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[8] Greaves-Walker, Soc. Chem. Industry (London) Jour., vol. 41, pp. 13t–14t, 1922; abstract in Eng. and Min. Jour., vol. 113, p. 536, 1922.

[9] Abstract in Chem. and Met. Eng., vol. 28, p. 394, 1923.

# ANTIMONY.

By Frank C. Schrader.

## THE ANTIMONY SITUATION.[1]

The antimony market in 1922 continued unsatisfactory. At the beginning of the year the price of antimony was 4½ cents a pound, or three-fourths of a cent less than at the beginning of 1921 and nearly 40 per cent below the average for the five years immediately preceding the war, and was less than the cost of production in the United States. The further decline in price to a very low level early in the year is attributed to slackness of the consuming trade and to the fact that large war stocks, including scrap, still remained in the hands of dealers and consumers. It is believed, however, that the old stocks will be consumed during 1923, and as the consumption is increasing the outlook for antimony mining is growing brighter.

The average price in 1922 was 5.42 cents a pound, which is half a cent more than the average price in 1921 (4.92 cents). The highest price of the year, 6.81 cents, was reached in October, and as low a price as was ever recorded, 4.13 cents (reached also in August, 1921), was reached in March. During the first quarter of the year the market was dull, and the range in price was only half a cent, the decline being almost steady from 4½ cents in January to 4⅛ cents at the middle of March. In April the market improved and became active and firm to strong, with a maximum of 5⅛ cents. In May the price advanced about one-eighth of a cent, owing, it is said, to expectation of a higher rate of import duty. During June the price declined to 5 cents. In July holders of stocks built hopes of higher prices on a higher tariff, but the market was without special activity, owing in part to the fact that large shipments were due to arrive soon from the Orient. The average price for the month was 5.08 cents. During August and September the price rose from 5¼ to 7 cents. From early in October to December 30, with the market in general quiet, the price gradually receded to 6.30 cents.

## USES AND SUBSTITUTES.

Metallic antimony is used chiefly in alloys with other metals, as in type metal, babbitt or bearing metal, Britannia or white metal, and antimonial or hard lead. The antimony oxides are used for making white enamel, and the oxides and sulphides as coloring agents and paint pigments.

[1] For a general discussion of this subject, the reader is referred to Mineral Resources for 1919.

New uses for antimony are gradually being found. The field of use for the compounds, especially the oxides in paint, is rapidly widening and seems to hold great promise—the result mainly of the researches of Cookson & Co.[2] in England, whose chief product resulting from this work is a pure-white antimony oxide known by the trade name "Timonox." Large quantities of this product have been imported into this country for the last four years by paint and varnish houses. An apparently similar oxide known as "Antox" is produced in Australia. The United States uses yearly about 2,000 tons of the white oxides and 1,200 tons of the sulphides, including vermilion and other colors.

Of the ten or more known substitutes for antimony the best recently found is a combination of calcium and barium, said to be extensively used with excellent results by the United Lead Co. in the hardening of lead.[3]

## DOMESTIC PRODUCTION.

The United States in 1915–1918 produced 10,750 short tons of antimony ore containing 4,310 tons of metal. There has been almost no production of ore since 1918.

The metallic antimony produced at smelters in the United States in 1917 and 1918 was 385 short tons from domestic ores and 4,672 tons from foreign ores. A small quantity was produced in 1919 and 1920, but the Geological Survey is not at liberty to publish the figures. There was no production in 1921 or 1922.

## SMELTER PRODUCTION OF ANTIMONIAL LEAD.

*By-product antimonial lead produced in the United States from both foreign and domestic ores, 1917–1922.*

| Year. | Short tons. | Antimony content. | |
|---|---|---|---|
| | | Short tons. | Value.[a] |
| 1917 | 18,646 | 2,759 | $1,142,000 |
| 1918 | 18,570 | 2,566 | 647,000 |
| 1919 | 13,874 | 1,943 | 319,000 |
| 1920 | 12,535 | 2,033 | 345,000 |
| 1921 | 10,064 | 1,589 | 158,000 |
| 1922 | 8,075 | 1,441 | 156,000 |

[a] Calculated on basis of average yearly price for ordinary brands of antimony as given by American Metal Market.

[2] Paint, Oil, and Chem. Rev., vol. 72, No. 4, p. 10, July 27, 1921; vol. 73, No. 2, Jan. 11, 1922; No. 3, Jan. 18, 1922.

[3] Chem. and Met. Eng., Dec. 28, 1921, p. 1181; Min. Mag. (London), vol. 26, p. 127, 1922.

## RECOVERY OF SECONDARY ANTIMONY.

During 1922 7,090 short tons of antimony was recovered from old alloys, scrap, and dross. Practically all of this was recovered in the form of alloys, not as metallic antimony.

*Antimony content of secondary alloys recovered from old alloys, scrap, and dross, 1917–1922.*

| Year. | Short tons. | Value.[a] |
|---|---|---|
| 1917 | 4,961 | $2,061,700 |
| 1918 | 5,226 | 1,317,000 |
| 1919 | 4,399 | 717,900 |
| 1920 | 5,600 | 938,560 |
| 1921 | 4,720 | 464,400 |
| 1922 | 7,090 | 765,700 |

[a] Calculated at average yearly price for ordinary brands of antimony.

## IMPORTS AND EXPORTS.

The accompanying statistics of imports are compiled from the records of the Bureau of Foreign and Domestic Commerce, United States Department of Commerce. The imports are reported as (1) imports for consumption, including merchandise entered for immediate consumption or withdrawn from bonded warehouses for consumption, and (2) total or general imports. Only general imports are listed by countries of origin.

*Antimony imported and entered for consumption in the United States, 1917–1922.*

| Year. | Antimony ore.[a] | | | Liquated antimony sulphide.[b] | | Metallic antimony.[c] | | Antimony oxides and other compounds.[d] | |
|---|---|---|---|---|---|---|---|---|---|
| | Short tons. | Antimony content. | | Short tons. | Value. | Short tons. | Value. | Short tons. | Value. |
| | | Short tons. | Value. | | | | | | |
| 1917 | 10,083 | 5,832 | $1,006,884 | 796 | $128,660 | 11,286 | $2,829,159 | 10 | $5,368 |
| 1918 | 3,363 | 1,425 | 177,731 | 833 | 113,258 | 14,011 | 3,065,619 | 18 | 11,904 |
| 1919 | 993 | 409 | 54,477 | 278 | 19,202 | 7,159 | 1,021,587 | 126 | 9,501 |
| 1920 | 1,709 | 682 | 70,285 | 1,375 | 123,902 | 9,817 | 1,216,376 | 298 | 25,260 |
| 1921 | 213 | 98 | 11,682 | 353 | 17,577 | 10,130 | 784,146 | 154 | 15,558 |
| 1922 | ..... | ..... | ..... | 689 | 40,108 | 9,344 | 659,242 | 379 | 65,538 |

[a] Classified in tariff classification as "Antimony ore and stibnite containing antimony."
[b] Classified in tariff classification as "Antimony matte, containing not more than 10 per cent of lead"; also as "needle or liquated antimony."
[c] Classified in tariff classification as "Antimony regulus or metal."
[d] Classified in tariff classification as "Antimony, oxide, salts, and compounds of."

*Antimony imported into the United States in 1919–1922.*[a]

[General imports.]

| Country. | Antimony ore. | | | Antimony metal.[b] | |
|---|---|---|---|---|---|
| | Short tons. | Antimony content. | | Pounds. | Value. |
| | | Pounds. | Value. | | |
| **1919.** | | | | | |
| England | | | | 90,048 | $8,803 |
| Canada | | 28 | $10 | 2,308,880 | 167,764 |
| Panama | 2 | 1,200 | 99 | | |
| Mexico | 297 | 219,048 | 11,332 | 757,076 | 60,571 |
| Chile[c] | 47 | 49,624 | 6,312 | | |
| Peru | 74 | 90,726 | 7,345 | | |
| China[d] | 455 | 362,326 | 23,936 | 7,847,840 | 459,613 |
| British India | | | | 224,000 | 10,976 |
| Hongkong[d] | 4 | 4,510 | 493 | 68,320 | 3,949 |
| Japan[d] | | | | 2,953,994 | 159,091 |
| | 879 | 727,462 | 49,527 | 14,250,158 | 870,767 |
| **1920.** | | | | | |
| England | | | | 125,539 | 14,638 |
| France | 467 | 315,861 | 10,605 | | |
| Canada | 132 | 19,457 | 2,179 | 225,272 | 19,111 |
| Panama | 65 | 80,293 | 3,856 | | |
| Bolivia | 388 | 335,061 | 22,941 | | |
| Chile[c] | 162 | 152,276 | 11,963 | | |
| China[d] | 420 | 450,293 | 14,185 | 21,564,851 | 1,218,802 |
| Hongkong[d] | 75 | 10,200 | 4,556 | 706,156 | 44,909 |
| Japan[d] | | | | 2,325,303 | 177,816 |
| | 1,709 | 1,363,441 | 70,285 | 24,947,121 | 1,475,276 |
| **1921.** | | | | | |
| England | | | | 302,457 | 14,586 |
| Germany | | | | 45 | 7 |
| Bolivia | 45 | 46,600 | 2,450 | | |
| Chile[c] | 49 | 54,401 | 3,334 | | |
| China[d] | | | | 20,530,079 | 672,501 |
| Hongkong[d] | 119 | 95,106 | 5,898 | | |
| Japan[d] | | | | 320,750 | 10,027 |
| | 213 | 196,107 | 11,682 | 21,153,331 | 697,121 |
| **1922.** | | | | | |
| England | | | | 45,474 | 3,335 |
| France | | | | 22 | 4 |
| Germany | | | | 515 | 65 |
| Netherlands | | | | 84,744 | 3,813 |
| Canada | | | | 8,960 | 364 |
| China[d] | | | | 16,976,726 | 562,181 |
| Hongkong[d] | | | | 627,424 | 30,531 |
| | | | | 17,743,865 | 600,293 |

[a] Includes large quantities of antimony metal that went into bonded warehouse and that are not included in the table of imports for consumption.

[b] Includes small quantities of liquated antimony sulphide, known in the trade as "crude antimony," "antimony matte," or "needle antimony."

[c] Imports credited to Chile originated mainly in Bolivia.

[d] Nearly all the imports of antimony ore and metal from Hongkong and Japan are of Chinese origin. Some of the material credited to other countries is possibly also of Chinese origin, having been transshipped in a foreign port.

There were no general imports of antimony ore in 1922. The imports of metal decreased about 16 per cent in quantity and 14 per cent in value as compared with 1921, owing mostly to the curtailment of shipments from China, Japan, and England. Receipts were irregularly distributed by months, the minimum being 528,745 pounds in December, and the maximum nearly 4,000,000 pounds in July. Those of March, August, and September were more than 2,000,000 pounds each, and those of January, February, and May more than 1,000,000 pounds each.

The imports from England decreased nearly 85 per cent, and those from China 17 per cent. No antimony was imported from Japan in 1922, but the imports from Hongkong increased from nothing to 627,000 pounds. Most of the material from Japan and Hongkong, however, originates in China. Imports from the Netherlands were received for the first time and amounted to nearly 85,000 pounds. This was probably derived from the Far East.

Large quantities of antimonial lead are imported into the United States as type metal.

*Type metal imported and entered for consumption, 1917–1922.*

| Year. | Type metal. | | Assumed antimony content. | |
|---|---|---|---|---|
| | Short tons. | Value. | Short tons. | Percentage. |
| 1917 | None. | | None. | |
| 1918 | 276 | $35,938 | 19 | 6.9 |
| 1919 | 6,697 | 816,642 | 1,197 | 17.9 |
| 1920 | 14,944 | 1,349,495 | 2,063 | 13.8 |
| 1921 | 19,485 | 1,191,553 | 4,132 | 21.2 |
| 1922 | 21,683 | 1,082,832 | 5,290 | 24.4 |

*Foreign antimony exported from the United States, 1917–1922.*[a]

| Year. | Ore. | | | Matte, regulus, or metal. | |
|---|---|---|---|---|---|
| | Short tons. | Antimony content. | | Pounds. | Value. |
| | | Pounds. | Value. | | |
| 1917 | | | | 989,477 | $169,260 |
| 1918 | | | | 1,410,970 | 164,666 |
| 1919 | 3 | 5,380 | $1,665 | 429,059 | 33,913 |
| 1920 | | | | 896,034 | 51,607 |
| 1921 | | | | 299,776 | 15,741 |
| 1922 | | | | 37,218 | 1,548 |

[a] During 1922 there was also exported, mainly to Canada, 224,619 pounds of regulus or metal of domestic manufacture, valued at $13,961. This is the first export of domestic antimony of which there is any record. However, antimony manufactured in the United States from foreign ores and exported would be classed as domestic exports.

## STOCKS.

The stock of metallic antimony and matte remaining in warehouse December 31, 1921, according to statistics of the Bureau of Foreign and Domestic Commerce, was 3,210,340 pounds. This stock was reduced to 2,651,210 pounds by the end of January, 1922. It then gradually rose to 3,337,785 pounds by April 30—the largest amount in warehouse during the year. Decreases in stock during May and June were followed by increases in July and August. This accumulation, however, was wiped out in September, a report of no stock being made at the end of that month. The three remaining months of the year showed a new collection of stocks which amounted to 1,013,008 pounds on December 31, 1922.

The average monthly amount of stocks in 1922 was 1,861,831 pounds, as compared with 2,801,966 pounds in 1921.

## PRICES.

The average yearly New York quotations for the ordinary grades of metallic antimony for the last 14 years, in cents per pound, according to the American Metal Market, are as follows:

| | | | |
|---|---|---|---|
| 1909–1913 | 7.4 | 1918 | 12.6 |
| 1914 | 8.5 | 1919 | 8.2 |
| 1915 | 29.5 | 1920 | 8.4 |
| 1916 | 25.3 | 1921 | 4.9 |
| 1917 | 20.7 | 1922 | 5.4 |

## WORLD'S PRODUCTION.

The following table shows the world's production of antimony for the years 1917–1922, so far as reasonably approximate data are available.

*World's production of antimony, 1917–1922, in metric tons.*

[Approximate recoverable metal content of ore produced, antimonial lead ores not included.]

| Country. | 1917 | 1918 | 1919 | 1920 | 1921 | 1922 |
|---|---|---|---|---|---|---|
| United States | 310 | 45 | ..... | ..... | ..... | 4 |
| Canada | 87 | 7 | 14 | ..... | ..... | ..... |
| Mexico | 2,647 | 3,269 | 628 | 1,572 | [a] 1,502 | (b) |
| Bolivia | 12,860 | 4,770 | 105 | (b) | 205 | (b) |
| Peru | 450 | 160 | 33 | 6 | 7 | (b) |
| Argentina | 812 | 360 | 27 | 50 | (b) | (b) |
| United Kingdom | 2 | 4 | (b) | 4 | (b) | (b) |
| Hungary | 444 | (b) | 77 | 314 | (b) | (b) |
| France | 2,354 | 1,634 | 990 | [c] 1,320 | 1,056 | 790 |
| Italy | 960 | 404 | 10 | 187 | 40 | (b) |
| Spain | 160 | [c] 20 | ..... | (b) | (b) | (b) |
| Serbia | 725 | (b) | (b) | (b) | (b) | (b) |
| Algeria | 4,550 | 2,218 | 723 | 1,000 | 103 | (b) |
| British Africa [d] | 300 | 99 | 21 | 73 | (b) | (b) |
| China [e] | 28,759 | 15,635 | 7,767 | 13,109 | 14,752 | [c] 1,726 |
| Japan | 8 | 41 | 1 | (b) | (b) | (b) |
| India | 182 | 2 | 7 | (b) | (b) | (b) |
| Indo-China | 600 | (b) | (b) | (b) | (b) | (b) |
| Asia Minor | 400 | 400 | 400 | 400 | 400 | (b) |
| Victoria | 1,004 | 576 | 580 | 375 | (b) | (b) |
| New South Wales | 150 | [c] 120 | 2,438 | 64 | (b) | (b) |
| | 57,764 | ..... | ..... | ..... | ..... | ..... |

[a] First half of year.
[b] No data.
[c] Incomplete data; actual production probably larger.
[d] The production came mostly from Transvaal and Southern Rhodesia.
[e] Production is based on the export figures given in the table on page 104.

## CONSUMPTION.

The world's yearly peace-time consumption of antimony from ore produced, not including antimonial lead ores, is about 22,000 metric tons, and that of the United States 10,000 tons. The United States also uses annually about 2,100 tons of virgin antimony contained in antimonial lead of domestic smelting and 3,500 tons of secondary antimony recovered from alloys, scrap, and dross, a total of 15,600 tons.

## FOREIGN DEPOSITS.

As the United States is largely dependent on foreign sources for its supply of antimony, a brief review of production in foreign countries follows.

## NORTH AMERICA.

*Canada.*[4]—In Canada, as in the United States, high prices continued for a long period would bring out a considerable production, but none is to be expected at peace-time prices. In 1915–1919 the production was the equivalent of 761 metric tons of metallic antimony. Official reports give no production of ore since 1919.

*Mexico.*—Mexico has produced a considerable quantity of antimony for many years. In 1912–1914 she exported 7,184 short tons of crude ore and regulus to England, and in 1914–1919 she exported 5,380 tons of ore and 3,735 tons of metal to the United States. The production of metallic antimony is reported as follows: 1912–1916, 8,439 metric tons; 1917–1921, 9,618 metric tons.[5]

The principal mines are in the Sierra Catorce, in the States of San Luis Potosi and Queretaro. It is probable that production will be maintained in the future, even during periods of low prices.

## SOUTH AMERICA.

*Argentina.*[6]—In 1911 Argentina produced 30 metric tons and in 1917 2,708 metric tons of antimony ore, which contained about 30 per cent of metal.

*Bolivia.*[7]—Under the stimulus of high war prices Bolivia from 1915 to 1918 produced large quantities of high-grade antimony ore and 42,566 metric tons of regulus. The ore shipped in 1915–1918 was 62,080 metric tons, of which about 50,000 tons went to England, 10,000 tons to the United States, and 2,000 tons to France.

The chief producing region is in the southern part of the Department of Potosi, particularly the Bustillo, Sur-Chicas, Nor-Chicas, and Porco districts.

*Peru.*—Extensive antimony deposits occur in many parts of Peru, but only a small quantity of antimony was produced before 1915; from 1915 to 1919 the production was 3,683 metric tons, which contained nearly 60 per cent of metal. More than 90 per cent of the production came from the Department of Puno, in southern Peru.

## EUROPE.

The principal antimony-producing countries in Europe are France and Italy, which, from 1913 to 1920, produced, respectively, 15,331 and 7,113 metric tons of regulus. Italy in 1921 produced 40 tons, and France in 1921 and 1922 respectively 1,056 and 790 tons.

## ASIA.

*China.*—For several years China has yielded more than 60 per cent of the world's production of antimony. In 1916 the exports reached their peak and amounted to the equivalent of 42,800 metric tons of metal.

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[4] Canada Dept. Mines, Mineral production, 1913–1919.
[5] Figures for 1916–1921 from Commerce Reports. Only first half of 1921 included.
[6] Estadística minera de la República: Min. agr., Dir. minas, geol. é hidrol. Bol. 13, Serie A (Minas), pp. 32, 37, 1920.
[7] Comercio especial de Bolivia; exportación, importación, bancos, 1915; 1918, pp. 105–107; 1919, pp. 149–150.

Exports in recent years have been as follows:

*Antimony exported from China, 1917–1922, in short tons.*[a]

| | 1917 | 1918 | 1919 | 1920 | 1921 | 1922 |
|---|---|---|---|---|---|---|
| Regulus | 16,338 | 15,853 | 6,843 | 10,721 | 13,962 | 1,834 |
| Crude | 22,202 | 1,880 | 2,354 | 5,023 | 2,794 | 112 |
| Ore | 4,254 | 529 | 639 | 1,490 | 1,297 | ..... |

[a] Given in the Chinese official trade reports in piculs of 133⅓ pounds each.

Antimony is found principally in the Provinces of Hunan, Yunnan, Kweichow, and Kwangsi. About 90 per cent of the production of China comes from the region about Changsha, the center of the smelting industry in Hunan Province. The most productive district is Kai-keng-shan (Shikungshan). The ore, which is mainly stibnite of remarkable purity, occurs as pockets and bunches in a flat bed of dolomitic limestone. The Wah Chang Mining & Smelting Co. largely controls the production. It operates smelters at Changsha, Yiyang, Yuling, and Sinwha, has a selling agency in New York, and has established a large business in the United States.

The Bureau of Foreign and Domestic Commerce has issued a circular for investors telling how to acquire financial interest in antimony properties in China.

*Borneo.*—British Borneo formerly produced considerable antimony. It exported much ore between 1859 and 1894, and about 1,220 tons in 1914 and 1915.

*India.*—The total Indian production of antimony ore in 1915–1919 was 1,609 tons. The ore reserves are said to be large but difficult of access.

*Indo-China.*—There are promising antimony deposits in French Indo-China. The metallic production in 1915 to 1917 was 903 metric tons. The ore exported to France in 1914–1917 was 2,329 tons.

*Japan.*—Very little antimony ore has been produced in Japan since the development of the Chinese deposits. The smelting of Chinese ores has become an important industry, and the smelter production rose to 10,800 tons in 1916.

*Turkey.*—The production of antimony in the Turkish Empire comes from the vilayets of Brusa and Smyrna, in eastern Asia Minor. The deposits are large and appear to be rich and capable of greater development. In 1911 the Djinli Kaya mine, near Eudemish, produced 1,500 tons of 50 per cent ore. Exports of antimony ore from Turkey to Great Britain in 1910–1919 were 2,768 metric tons.

## AFRICA.

*Algeria.*[8]—The Algerian deposits are probably capable of considerable development. The ores are nearly all oxidized. They contain about 44 per cent metallic antimony. In 1916–1921 58,000 metric tons of ore containing approximately 22,000 tons of metal was produced. During the war large deposits were developed at Ain Kerma and supplied antimony to France.

[8] Econ. Review, vol. 5, No. 20, p. 428, Mar. 24, 1922.

*British Africa.*—The most promising antimony deposits in British Africa are those of the Murchison Range, in northern Transvaal. In 1913–1919 there was shipped from Transvaal 1,610 metric tons of concentrates and crude. It is reported that 72 tons of regulus was produced in 1920. Deposits occur also in the Steynsdorp district, the Forbes Reef district, Swaziland, and Rhodesia.[9]

## AUSTRALIA.[10]

The only important antimony-producing district in Australia is the Costerfield district of Victoria. The concentrates average 48 per cent of antimony and 2½ ounces of gold to the ton. The deposits are very large and are workable to depths of more than 900 feet. The production in 1913–1920 was 17,367 long tons. The current output is about 300 tons a month. It is used with complete success chiefly in making "Antox," white oxide of antimony, for paint pigment and regulus. A large plant is being built near the mines by the new owner, the Antox Syndicate (Ltd.), of Sydney.

The antimony metal and ore produced in New South Wales in 1912–1920 was 11,000 long tons. The Hillgrove district was formerly a considerable producer, and its highest annual output was 8,687 tons of ore in 1919.

Imports of antimony ore into Great Britain from Australia in 1915 amounted to 3,854 long tons, valued at $471,700.

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[9] Rhodesia Chamber of Mines, Report of executive committee, 1920; South Africa Min. and Eng. Jour., vol. 23, p. 866, Mar. 19, 1921.

[10] Min. Jour. (London), Aug. 7, 1920; Sept. 3, 1921, p. 652; May 20, 1922, p. 381. Eng. and Min. Jour.-Press, vol. 113, p. 1008, 1922.

# CHROMITE.

By Edward Sampson.[1]

## PRODUCTION.

Chromite mining continued in 1922 on about the same scale as in 1921. The total quantity of domestic ore sold was 355 long tons. The average tenor of this ore was 49.7 per cent $Cr_2O_3$, and the total quantity shipped was thus equivalent to 353 tons of 50 per cent ore.

All the producers have again permitted the separate publication of their figures, so that an analysis of the production is possible.

*Crude chromite mined and shipped from mines in the United States in 1922, by States.*

| State. | Ore containing 45 per cent or more of chromic oxide. | | | Ore containing 35 to 45 per cent of chromic oxide, mined (long tons). | Total value of ore shipped. |
|---|---|---|---|---|---|
| | Mined (long tons). | Shipped (long tons). | Average value. | | |
| California | 200 | 163 | $20.58 | ..... | $3,354 |
| Maryland | 113 | 113 | 29.22 | ..... | 3,302 |
| Montana | ..... | ..... | ..... | 10 | ..... |
| Oregon | 97 | 79 | 8.00 | ..... | 632 |
| | 410 | 355 | 20.53 | 10 | 7,288 |

In California D. J. Sullivan continued operations at Gorge, in Placer County. P. A. Arata shipped from San Luis Obispo, in San Luis Obispo County. In Oregon F. W. Peet shipped from Baker City.

The Maryland Chromite Mining Co. shipped 113 tons of 47 per cent ore from its mine at Jarrettsville, Md. In May, 1923, this company reported that it was actively engaged in diamond drilling and had located nine pockets of ore.

[1] The figures showing domestic production have been compiled by Miss H. M. Meyer, of the U. S. Geological Survey, and those for imports by J. A. Dorsey, of the U. S. Geological Survey, from records of the Bureau of Foreign and Domestic Commerce.

## IMPORTS.

*Crude chromite imported into the United States, 1918–1922, in long tons.*

| Country. | 1918 | 1919 | 1920 | 1921 | 1922 | | Average value per ton. | | |
|---|---|---|---|---|---|---|---|---|---|
| | | | | | Quantity. | Value. | 1920 | 1921 | 1922 |
| Australia | 15,976 | 13,161 | 2,778 | ..... | 4,000 | $23,194 | $33.95 | ..... | $5.80 |
| Belgium | ..... | ..... | 239 | ..... | ..... | ..... | 35.51 | ..... | ..... |
| Brazil | 17,854 | 4,800 | 3,451 | ..... | ..... | ..... | 21.36 | ..... | ..... |
| British South Africa | 521 | 29 | 39,400 | 23,318 | 41,002 | 303,032 | 6.81 | $3.41 | 7.39 |
| Canada | 20,949 | 8,941 | 8,491 | 7,554 | 801 | 8,613 | 20.00 | 5.96 | 10.75 |
| Cuba | 8,821 | 14,461 | 710 | 600 | 1 | 74 | 28.73 | 30.00 | 74.00 |
| England | 4 | ..... | 3,799 | ..... | 1,900 | 20,805 | 30.46 | ..... | 10.95 |
| French Oceania | 25,761 | 7,125 | 56,682 | 35,108 | 7,500 | 20,590 | 10.79 | 5.64 | 2.75 |
| Germany | ..... | ..... | 1 | ..... | ..... | ..... | 83.00 | ..... | ..... |
| Greece | ..... | ..... | 5,302 | 8,104 | 8,600 | 106,927 | 27.25 | 20.22 | 12.43 |
| Guatemala | 1,193 | 1,659 | 1,122 | 401 | ..... | ..... | 61.46 | 52.08 | ..... |
| India | ..... | ..... | 4,500 | 928 | 12,677 | 125,137 | 16.67 | 12.03 | 9.87 |
| New Zealand | ..... | 693 | ..... | ..... | ..... | ..... | ..... | ..... | ..... |
| Other British Oceania | 1,063 | ..... | ..... | ..... | ..... | ..... | ..... | ..... | ..... |
| Portuguese East Africa | 8,000 | 4,000 | 11,000 | ..... | 7,100 | 28,926 | 3.97 | ..... | 4.07 |
| Other Portuguese Africa | | | | | 4,000 | 57,480 | | | 14.37 |
| Spain | ..... | 3,035 | 40 | ..... | ..... | ..... | 31.25 | ..... | ..... |
| Turkey in Asia[a] | ..... | 3,500 | 12,760 | 5,822 | 2,500 | 46,408 | 17.71 | 20.26 | 18.56 |
| Turkey in Europe | ..... | ..... | ..... | 1 | ..... | ..... | ..... | 99.00 | ..... |
| | 100,142 | 61,404 | 150,275 | 81,836 | 90,081 | 741,186 | 12.79 | 8.00 | 8.23 |

[a] 1922, Greece in Asia.

The outstanding features of the import trade in chromite in 1922 are a great falling off in the imports from French Oceania (New Caledonia) and a corresponding increase in those from India (Baluchistan field) and Africa (Rhodesian field). These changes were brought about by the enforced reduction in production in New Caledonia, where, at the Tiebaghi mine, the chief source of supply, extensive development work must be done before production on a large scale can be resumed.

The increase in the average value per ton of ore from British South Africa and Portuguese Africa appears to indicate the exhaustion of the large stocks of Rhodesian ore, which early in 1922 had been accumulated both at the mines and ports and at London. The value of ore from French Oceania in 1922 was extremely low and probably indicates that of ore taken on as ballast. The low unit value of ore mined in Greece in 1922 as compared with preceding years is probably due to the fact that shipments were made largely if not entirely from one mine to one American consumer and therefore represented a more concentrated business. The figures representing the average value of ore in Baluchistan show a marked decrease, which is due to a much greater volume of business.

The imports of chromite since 1909 are shown in Figure 8.

The following analyses have been selected by an importer of large quantities of chromite as representative of the ore imported in 1922. These analyses represent lots as sampled commercially, not specimens.

*Analyses of chrome ore imported in 1922.*

| | 1 | 2 | 3 | 4 | 5 | 6 | 7 |
|---|---|---|---|---|---|---|---|
| $Cr_2O_3$ | 55.40 | 50.40 | 55.76 | 52.60 | 51.10 | 41.66 | 44.45 |
| $Al_2O_3$ | 13.19 | 14.48 | 10.06 | 11.32 | 7.60 | 18.24 | 12.18 |
| $Fe_2O_3$ | 3.71 | 2.00 | 3.05 | .70 | 1.03 | (*a*) | 14.22 |
| FeO | 12.77 | 11.70 | 14.45 | 13.30 | 21.44 | 14.70 | (*b*) |
| MgO | 11.90 | 10.80 | 13.32 | 16.40 | 12.10 | 16.66 | 17.70 |
| CaO | .50 | 1.00 | .65 | 1.10 | .60 | 5.76 | None. |
| MnO | .52 | .50 | .40 | .30 | .30 | ..... | ..... |
| $SiO_2$ | .32 | 5.50 | 1.80 | 1.86 | 4.50 | 2.00 | 6.20 |
| $SO_3$ | Tr. | .14 | Tr. | .10 | .05 | ..... | .70 |
| $P_2O_5$ | .12 | ..... | ..... | ..... | ..... | ..... | .06 |
| $H_2O\pm$ | 1.55 | 3.45 | .55 | 2.30 | 1.30 | .98 | Not det. |
| | 99.98 | 99.97 | 100.04 | 99.98 | 100.02 | 100.00 | 95.51 |
| Cr | 37.89 | 34.47 | 38.14 | 35.98 | 34.95 | 28.50 | 30.40 |
| Fe | 12.51 | 10.49 | 13.36 | 10.82 | 17.38 | 11.42 | ..... |
| Cr: Cr+Fe | .75 | .77 | .73 | .77 | .67 | .72 | ..... |

*a* Probably included with FeO.
*b* Probably included with $Fe_2O_3$.

1. New Caledonian ore (Tiebaghi mine).
2. Rhodesian hard ore.
3. Rhodesian friable ore (average of three analyses).
4. Baluchistan ore.
5. State of Mysore ("Madras") ore.
6. Grecian ore (Volo mine).
7. Turkish ore (Macri field.)

The imports of chromium compounds are small as compared with the consumption.

*Chromium compounds imported for consumption in the United States, 1918–1922.*

| Year. | Chromic acid. | | | Chromate and bichromate of potash. | | | Chromate and bichromate of soda. | | | Chrome or chromium and ferrochromium. | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | Pounds. | Value. | | Pounds. | Value. | | Pounds. | Value. | | Long tons. | Value. | |
| | | Total. | Average. | | Total. | Average. | | Total. | Average. | | Total. | Average. |
| 1918 | 9,512 | $1,857 | $0.19 | 20 | $8 | $0.40 | 5,102 | $1,184 | $0.23 | ..... | ..... | ..... |
| 1919 | ..... | ..... | ..... | 15,450 | 4,271 | .28 | ..... | ..... | ..... | 414 | $100,404 | $243 |
| 1920 | 1,100 | 90 | .08 | 4,414 | 2,690 | .61 | ..... | ..... | ..... | 1,751 | 428,619 | 245 |
| 1921 | 1,969 | 674 | .34 | 73,011 | 6,772 | .09 | 64,236 | 5,308 | .08 | 452 | 106,669 | 236 |
| 1922 | 4,663 | 915 | .20 | 8,584 | 1,676 | .20 | 22,731 | 1,540 | .07 | 397 | 118,870 | 299 |

## CONSUMPTION.

*Domestic sales, imports, and supply of chromite in the United States, 1918–1922.*

| Year. | Domestic sales. | | | Imports. | | | Apparent available supply. | | |
|---|---|---|---|---|---|---|---|---|---|
| | Long tons. | Value. | | Long tons. | Value. | | Long tons. | Value. | |
| | | Total. | Average. | | Total. | Average. | | Total. | Average. |
| 1918 | 82,430 | $3,955,567 | $47.99 | 100,142 | $2,892,825 | $28.89 | 182,572 | $6,848,392 | $37.51 |
| 1919 | 5,079 | 129,302 | 25.46 | 61,404 | 1,381,497 | 22.50 | 66,483 | 1,510,799 | 22.72 |
| 1920 | 2,502 | 44,857 | 17.93 | 150,275 | 1,921,824 | 12.79 | 152,777 | 1,966,681 | 12.87 |
| 1921 | 282 | 2,900 | 10.28 | 81,836 | 654,602 | 8.00 | 82,118 | 657,502 | 8.01 |
| 1922 | 355 | 7,288 | 20.53 | 90,081 | 741,186 | 8.23 | 90,436 | 748,474 | 8.28 |

In Figure 8 data concerning the chromite industry are presented in graphic form. These curves give at a glance the relation of present conditions to war conditions and to pre-war conditions. Curve 1 shows the annual supply, which is averaged over two-year periods because information is not available as to unconsumed stocks. Curves 2 and 3 show the relation between imports and domestic pro-

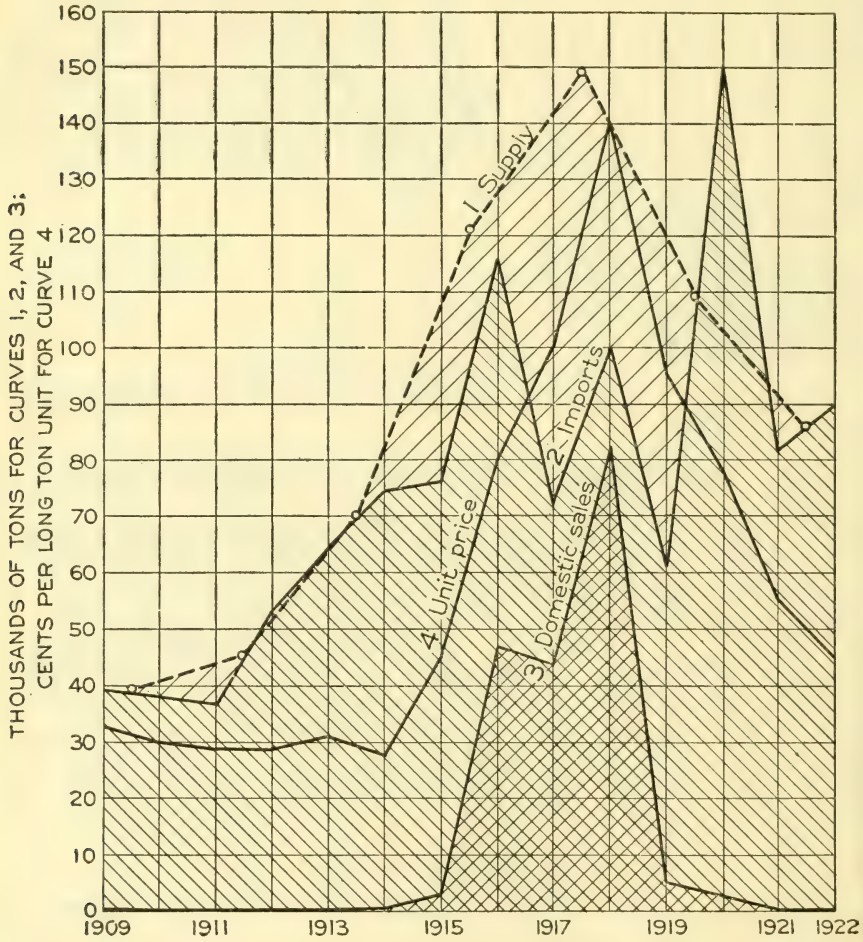


FIGURE 8.—Curves showing domestic sales, imports, supply, and prices of chromite, 1909–1922.

duction. Domestic production became a factor in the chromite market only because the imports were curtailed. The relation between domestic production and price is shown by curves 3 and 4.

In 1918 the War Industries Board made an estimate of the amount of chromite required by the several industries that use it. In November, 1922, one of the large importers of chromite made for the writer the following estimate of what he considered the requirements of the industries. The estimate made in 1918 assumed a consumption of 130,000 tons, and that made in 1922 assumed a consumption of 110,000 tons, which represents the normal capacity of

the industries rather than the actual quantity used in 1922. The two estimates are given below.

*Chromite required by different industries in the United States in 1918 and 1922, in per cent.*

| | 1918 | 1922 |
|---|---|---|
| Ferrochrome | 52 | 40 |
| Refractories | 17 | 35 |
| Chemicals | 31 | 25 |
| | 100 | 100 |

The change in the relative quantities of chromite used for the purposes indicated is due principally to a change in the requirements from those of war to those of peace. It is reported that chromite has found an increased use in refractories owing to the duty on magnesite and the absence of duty on chromite.

## WORLD'S PRODUCTION.[2]

*Crude chromite produced by different countries, 1918–1922, in metric tons.*

| Country. | 1918 | 1919 | 1920 | 1921 | 1922 |
|---|---|---|---|---|---|
| Australia [a] | 611 | 254 | 1,643 | 63 | (b) |
| Brazil [c] | 18,141 | 4,877 | 3,506 | ..... | ..... |
| Canada [d] | 19,952 | 7,748 | 9,993 | 2,538 | 986 |
| Cuba [c] | 8,963 | 14,693 | 721 | 610 | ..... |
| Great Britain [e] | 142 | 152 | 1,118 | ..... | (b) |
| Greece [f] | 2,640 | 4,070 | 12,492 | 5,919 | 10,000 |
| Guatemala [c] | 1,212 | 1,686 | 1,140 | 401 | ..... |
| India [g] | 58,697 | 37,024 | 27,231 | 35,320 | 31,000 |
| Japan [h] | 6,247 | 6,012 | 3,969 | 3,368 | (b) |
| New Caledonia [i] | 55,177 | 23,548 | 91,534 | 29,458 | 20,000 |
| Norway [j] | 2,783 | 460 | ..... | ..... | (b) |
| Rhodesia [k] | 28,382 | 32,007 | 54,674 | 45,529 | 84,799 |
| Russia [l] | (b) | (b) | 2,965 | 4,013 | (b) |
| Turkey (Asia Minor) [m] | (b) | (b) | 25,000 | (b) | 2,540 |
| United States | 83,753 | 5,161 | 2,542 | 287 | 361 |
| Yugoslavia [n] | ..... | ..... | (b) | (b) | (b) |
| | 286,700 | 137,692 | 238,528 | 127,506 | 149,686 |

[a] New South Wales, Dept. Mines Ann. Repts. Queensland, Undersecretary for Mines Ann. Repts.
[b] Figures not yet available.
[c] Imports into United States, Bur. Foreign and Domestic Commerce.
[d] 1918–1920: Canada Dept. Mines, Mines Branch, Ann. Repts. 1921–1922: Dominion Bur. Statistics Prelim. Rept., 1922.
[e] 1918–1920: Mines and Quarries, General Repts., pt. 3. 1921: Sec. Mines and H. M. Chief Inspector for Mines Dept. Ann. Rept.
[f] 1918: Information furnished by United States consulate general, Athens, Greece. 1919–1920: Tableaux statistiques du mouvement minier de la Grèce. 1921: Information furnished by Direction du Service des mines, Athens, Greece. 1922: Estimate.
[g] 1918–1921: India Geol. Survey Records. 1922: Estimate.
[h] 1918–1919: Japan Dept. Commerce Bur. Mines. 1920–1921: Information from United States consulate, Yokohama, Japan.
[i] 1918: Statistique de l'industrie minérale en France et en Algérie. 1919–1921: Bulletin de l'Agence des colonies. 1922: Mining Jour., London. (Figures represent exports.)
[j] Norges Bergverksdrift.
[k] Rhodesia, Sec. Mines Repts.
[l] 1920: Mining Jour., London. 1921: U. S. Dept. Commerce, Commerce Repts., June 26, 1922.
[m] 1920: Estimate based largely on information furnished by E. J. Lavino & Co., importers. 1922: Estimate.
[n] Wray, D. A., Report of geologist attached to the British Economic Mission to Serbia, 1921.

[2] Prepared from data compiled by W. I. Whiteside, of the U. S. Geological Survey.

## PRICES.

The price of imported chromite showed little variation in 1922. The average price on the basis of 50 per cent ore was about 46 cents per unit of chromic oxide ($Cr_2O_3$), as quoted by the Engineering and Mining Journal-Press. The lowest prices were reached in February and March—for 40 to 45 per cent ore $18–$20, and for 45 to 50 per cent ore $19–$21. The highest prices were reached at the end of the year, when Indian (Baluchistan) ore was quoted at $18.50 per long ton and Rhodesian and New Caledonian ore at $26. All these prices are c. i. f. Atlantic ports.

# QUICKSILVER.

By F. L. Ransome.

## STATISTICAL SUMMARY.

*Quicksilver produced in the United States in 1922.*

| State. | Ore treated (short tons). | Quicksilver obtained. | | |
|---|---|---|---|---|
| | | Percentage tenor won. | Quantity (flasks of 75 pounds). | Value. |
| California | 20,354 | 0.52 | [a] 3,405 | $196,741 |
| Texas, Nevada, and Oregon | 22,730 | .49 | 2,970 | 171,607 |
| | 43,084 | .51 | 6,375 | 368,348 |

[a] Includes 568 flasks obtained by washing and not considered in calculating percentage tenor.

Average price per flask: San Francisco, $57.78; New York, $58.95; London, £11 11s. 6d.

Number of mines producing, 10.

Increase in production in 1922 from 1921, 36 flasks.

Exports from the United States, 21,834 pounds, or 291 flasks.

Imports into the United States, 1,269,004 pounds, or 16,920 flasks.

Apparent consumption of quicksilver in the United States (domestic production plus imports minus exports), 23,004 flasks.

## INTRODUCTION.

The condition of the quicksilver-mining industry in the United States in 1922 remained nearly the same as in 1921. The prices obtainable for the metal were higher, but the mines have responded very sluggishly to this incentive to increased production, a result that tends to confirm the conclusion, expressed in previous reports, that the known available supplies of domestic quicksilver ore have been reduced to so low a point that only under extraordinary conditions can any general revival of the industry be expected. The production of 36,159 flasks in 1917 was due to a wholly unusual demand and a resulting unprecedented price. It was a spurt, followed by a correspondingly marked decline. The year 1922 shows a very slight recovery from this depression, and the upward trend will probably be more evident in 1923, although it is not expected that the output for this year will exceed 10,000 flasks. It is doubtful whether the help to producers afforded by the new duty of 25 cents a pound much more than offsets the increasing difficulty that mine managers are experiencing in finding new ore and in obtaining competent and steady workers.

## PRODUCTION.

### WORLD'S PRODUCTION.

In the accompanying table are given the best figures available for the world's production of quicksilver in 1918–1921; figures for 1922 are not yet at hand. The foreign figures, generally published in metric tons, are calculated to flasks of 75 pounds net.

Italy in 1921 was well in the lead as the world's largest producer of quicksilver, although her output was far below that which the deposits now in her possession showed themselves capable of yielding before the war.

The Spanish production, chiefly from Almaden, was considerably less than half of what that country has produced in some previous years.

The output of the United States, which in 1917 was 36,159 flasks, had dwindled in 1921 to only 6,339 flasks, with no indication of substantial increase in 1922.

*World's production of quicksilver, 1918–1921.*

[1 metric ton = 29.395 flasks.]

| Country. | 1918 | | 1919 | | 1920 | | 1921 | |
|---|---|---|---|---|---|---|---|---|
| | Flasks. | Metric tons. | Flasks. | Metric tons. | Flasks. | Metric tons. | Flasks. | Metric tons. |
| United States | 32,883 | 1,118.6 | 21,415 | 728.5 | 13,392 | 455.6 | 6,339 | 215.6 |
| Spain [a] | 16,677 | 567.3 | 36,055 | 1,226.6 | 25,330 | 861.7 | 18,678 | 635.4 |
| Italy [b] | 30,512 | 1,038.0 | 24,839 | 845.0 | 41,182 | 1,401.0 | 31,482 | 1,071.0 |
| Austria | 12,346 | [c] 420.0 | [d] | [d] | [d] | [d] | [d] | [d] |
| Hungary | 2,352 | [e] 80.0 | [f] | [f] | [f] | [f] | [f] | [f] |
| Czechoslovakia | ..... | ..... | 2,352 | [e] 80.0 | 2,352 | [e] 80.0 | ..... | ..... |
| Mexico [g] | 4,809 | 163.6 | 3,495 | 118.9 | 2,225 | 75.7 | 1,352 | 46.0 |
| Other countries [h] | 1,000 | 34.0 | 1,000 | 34.0 | 1,500 | 51.0 | 1,500 | 51.0 |
| | 100,579 | 3,421.5 | 89,156 | 3,033.0 | 85,981 | 2,925.0 | 59,351 | 2,019.0 |

[a] Estadística minera de España, Madrid.
[b] Riv. servizio min., Rome.
[c] Castelli, Gaetano, La mina de mercurio de Idria: Rev. minera, metalúrgica y de ingeniería, Madrid, Aug. 24, 1921.
[d] Output of Idria mine credited to Italy.
[e] Statistics not available; estimate only.
[f] Deposits now in Czechoslovakia.
[g] Bol. minero, Dept. de Minas, Mexico.
[h] Estimated as flasks and quantity in metric tons calculated therefrom.

### DOMESTIC PRODUCTION.

Only 10 mines were reported as productive in 1922. Two of these yielded over 2,000 flasks each, one yielded nearly 900 flasks, and only three others yielded over 100 flasks each. The Chisos mine in Texas and the New Almaden (Senator) mine in California produced more then 75 per cent of the whole.

According to reports to the Geological Survey from individual mining companies or mine operators, the output of quicksilver in the United States in 1922 was 6,375 flasks of 75 pounds each, against 6,339 flasks in 1921 and 13,392 flasks in 1920.

At the average price for the year, $57.78 a flask, based on quotations for domestic quicksilver in San Francisco published weekly by the Engineering and Mining Journal-Press, the value of the output in

1922 was $368,348, an increase of $67,753 from 1921. The producers of 6,277 of the 6,375 flasks gave in their statistical reports the value of the product. On the supposition that this was in general the amount received from sales it corresponds to an average selling price of $56.35 a flask, or $1.43 less than the average quotation in San Francisco.

*Quicksilver produced in the United States, 1920–1922, by States.*

| State. | 1920 | | 1921 | | 1922 | |
|---|---|---|---|---|---|---|
| | Flasks. | Value. | Flasks. | Value. | Flasks. | Value. |
| California | 9,849 | $784,571 | 3,055 | $144,868 | 3,405 | $196,741 |
| Oregon | 24 | 1,912 | | | | |
| Texas | 3,436 | 273,712 | [a] 3,284 | 155,727 | 2,970 | 171,607 |
| Nevada | 83 | 6,612 | | | | |
| | 13,392 | 1,066,807 | 6,339 | 300,595 | 6,375 | 368,348 |

[a] Includes 1 flask from Idaho.

For a table showing the quicksilver produced in the United States from 1850 to 1921 the reader is referred to the report for 1921.

## QUANTITY AND TENOR OF ORE MINED AND TREATED.

Only two sets of retorts were reported as in operation on ore in 1922. One reduced about 128 tons of sorted ore and obtained a yield of 255 flasks. The ore after sorting carried 7.5 per cent of quicksilver. The other produced 20 flasks from an unrecorded quantity of ore.

The total quantity of quicksilver ore reported as mined in the United States in 1922 is 47,244 tons. In addition, an unreported quantity of material was handled which yielded 901 flasks of quicksilver. Of this quantity 568 flasks was won by washing soil and gravel from the site of old furnaces and condensers at New Almaden. Ore reported as treated in furnaces amounted to 42,956 tons, which yielded 5,454 flasks of quicksilver—a rate of 0.48 per cent, or 9.6 pounds to the ton of ore. This low result appears to be due to the fact that one mine treated a large quantity of ore in a new Scott furnace and obtained relatively little quicksilver, most of the metal apparently remaining in the furnace and condensers as absorbed quicksilver or as soot. If the figures for this mine are disregarded 28,406 tons of ore was treated in furnaces and yielded 5,245 flasks—a rate of 0.69 per cent, or 13.8 pounds to the ton. In 1921 the average yield of furnace ore was 0.62 per cent, or 12.4 pounds to the ton. With the ore passed through the new furnace omitted, the average tenor of the Texas furnace ore was 1.16 per cent and of the California furnace ore 0.50 per cent.

## METHODS OF PRODUCTION.

The ores of quicksilver, unlike those of most metals that are won by smelting, are without exception in this country treated at the mines, and the liquid metal is shipped as a finished commercial product.

Methods of treatment have been briefly described in the reports for 1917, 1918, and 1919.

## PRICES.

The domestic price of quicksilver declined slightly from $51 at New York and $50 at San Francisco early in January to $48 at New York and $47.50 at San Francisco in February. From the first of March the rise was fairly steady to $74 at New York and $71.30 at San Francisco at the end of the year.

The tariff act of 1922, which went into effect September 22, placed a duty of 25 cents a pound on imported quicksilver, equivalent to $18.75 a flask. At the end of the year the directors of the great Almaden mine in Spain, where extensive improvements have been in progress, reduced the price of quicksilver at the mine to the equivalent of about $25 per flask.

In London the price of quicksilver in 1922 was very little above that for 1921.

*Average yearly prices of quicksilver in the United States and the United Kingdom, 1911–1922.*

[Per flask of 75 pounds.]

| Year. | San Francisco [a] (domestic). | New York.[b] | London.[c] £ | s. | d. | Year. | San Francisco [a] (domestic). | New York.[b] | London.[c] £ | s. | d. |
|---|---|---|---|---|---|---|---|---|---|---|---|
| 1911 | $46.01 | $46.54 | 8 | 4 | 11 | 1917 | $105.32 | $106.30 | 22 | 4 | 3 |
| 1912 | 42.05 | 42.46 | 8 | 2 | 10 | 1918 | 117.50 | 123.47 | | (e) | |
| 1913 | 40.23 | 39.54 | 7 | 9 | 2 | 1919 | 90.29 | 92.15 | 20 | 9 | 5½ |
| 1914 | 49.05 | 48.31 | [d] 7 | 15 | 0 | 1920 | 79.66 | 81.12 | 20 | 14 | 9 |
| 1915 | 85.80 | 87.01 | 14 | 10 | 8 | 1921 | 47.42 | 45.46 | 11 | 3 | 5 |
| 1916 | 125.89 | 125.49 | 17 | 2 | 10 | 1922 | 57.78 | 58.95 | 11 | 11 | 6 |

[a] Min. and Sci. Press, San Francisco.
[b] Eng. and Min. Jour., New York.
} Eng. and Min. Jour.-Press in 1922.
[c] Min. Jour. (London).
[d] Metal exchange closed about three months after outbreak of war. Average based on 37 weeks only.
[e] Quoted as "nominal" only.

Although San Francisco is commonly referred to as the "primary market" for quicksilver in the United States, from the fact that the greater part of this metal produced in the country comes from the Pacific coast and goes through the hands of San Francisco firms, yet it should be noted that that city is not a market in the same sense as New York. Most of the quicksilver that passes nominally through San Francisco is handled on commission and is sold in New York, which consequently is the great distributing point of quicksilver to the actual customers. At the present low ebb in California production the supremacy of that State as a quicksilver producer is not as pronounced as formerly.

*Prices of domestic quicksilver at San Francisco, 1920–1922, by months.*

[Per flask of 75 pounds.]

| Month. | 1920 | 1921 | 1922 | Month. | 1920 | 1921 | 1922 |
|---|---|---|---|---|---|---|---|
| January | $89.00 | $50.00 | $48.50 | July | $88.00 | $47.75 | $54.55 |
| February | 81.00 | 48.75 | 47.65 | August | 85.00 | 47.50 | 56.15 |
| March | 87.00 | 45.88 | 48.65 | September | 75.00 | 47.50 | 63.95 |
| April | 100.00 | 46.00 | 50.85 | October | 71.00 | 46.25 | 70.45 |
| May | 87.00 | 50.00 | 54.40 | November | 56.00 | 40.40 | 70.45 |
| June | 85.00 | 49.50 | 54.75 | December | 52.50 | 49.50 | 70.75 |

## IMPORTS AND EXPORTS.

The import duty on quicksilver under the Underwood tariff bill, enacted in 1913 and in force up to September 21, 1922, was 10 per cent ad valorem. The tariff act of 1922 placed a duty on imported quicksilver equivalent to $18.75 a flask.

In the following tables[1] are given imports of quicksilver for domestic consumption, total annual exports, and annual exports by countries. The figures, in pounds, have been calculated to the approximate equivalent in metric tons and in flasks.

*Quicksilver imported and entered for consumption in the United States, 1918–1922.*

| Year. | Pounds. | Metric tons. | Flasks. | Value. |
|---|---|---|---|---|
| 1918 | 503,907 | 228.57 | 6,719 | $533,622 |
| 1919 | 797,613 | 361.79 | 10,635 | 791,226 |
| 1920 | 1,062,647 | 482.01 | 14,169 | 971,510 |
| 1921 | 795,078 | 360.64 | 10,601 | 457,993 |
| 1922 | 1,269,004 | 575.61 | 16,920 | 757,842 |

*Quicksilver exported from the United States, 1918–1922.*

| Year. | Pounds. | Metric tons. | Flasks. | Value. |
|---|---|---|---|---|
| 1918 | 232,346 | 105.39 | 3,098 | $338,620 |
| 1919 | 683,004 | 309.80 | 9,107 | 817,328 |
| 1920 | 116,493 | 52.84 | 1,553 | 129,993 |
| 1921 | 29,501 | 13.38 | 393 | 18,869 |
| 1922 | 21,834 | 9.90 | 291 | 15,910 |

*Domestic quicksilver exported from the United States, 1921–1922, by countries.*

| Country. | 1921 | | 1922 | |
|---|---|---|---|---|
| | Pounds. | Value. | Pounds. | Value. |
| North America: | | | | |
| Canada | 11,102 | $6,955 | 11,812 | $8,315 |
| Mexico | 1,169 | 818 | 1,335 | 1,061 |
| Central America: | | | | |
| Costa Rica | 339 | 188 | 600 | 471 |
| Guatemala | 150 | 94 | 95 | 75 |
| Honduras | 150 | 105 | 83 | 83 |
| Nicaragua | | | 1,488 | 1,010 |
| Panama | 47 | 44 | 76 | 52 |
| Salvador | 75 | 48 | 105 | 100 |
| West Indies: | | | | |
| Cuba | 150 | 92 | 10 | 12 |
| Dominican Republic | 10 | 11 | 12 | 19 |
| South America: | | | | |
| Argentina | | | 75 | 60 |
| Brazil | 100 | 50 | 300 | 229 |
| Chile | | | 90 | 104 |
| Colombia | 1,830 | 1,383 | 2,131 | 1,559 |
| Ecuador | | | 75 | 75 |
| Guiana: | | | | |
| British | | | 75 | 53 |
| French | | | 150 | 111 |
| Paraguay | | | 10 | 12 |
| Peru | 716 | 529 | 57 | 43 |
| Venezuela | | | 779 | 563 |
| Asia: | | | | |
| China | 10 | 10 | 50 | 40 |
| Chosen (Korea) | 1,578 | 960 | 1,939 | 1,409 |
| Far Eastern Republic | | | 50 | 45 |
| India (British) | | | 10 | 10 |
| Japan | 11,250 | 6,975 | | |
| Palestine and Syria | | | 10 | 10 |
| Philippine Islands | 600 | 465 | 317 | 256 |
| East Indies—Dutch | 225 | 142 | | |
| Oceania: New Zealand | | | 100 | 133 |
| | 29,501 | 18,869 | 21,834 | 15,910 |

[1] Compiled by J. A. Dorsey, of the U. S. Geological Survey, from the records of the Bureau of Foreign and Domestic Commerce, Department of Commerce.

## USES OF QUICKSILVER.

The uses of quicksilver, which are exceedingly varied, have been rather fully described in previous reports, which are still available for distribution.

## SUPPLIES.

*Supplies of quicksilver in the United States, 1918–1922.*

| Year. | Production. | | Imports. | | Exports. | | Apparent consumption. | |
|---|---|---|---|---|---|---|---|---|
| | Flasks. | Value. | Flasks. | Value. | Flasks. | Value. | Flasks. | Value. |
| 1918 | 32,883 | $3,863,752 | 6,719 | $533,622 | 3,098 | $338,620 | 36,504 | $4,058,754 |
| 1919 | 21,415 | 1,933,560 | 10,635 | 791,226 | 9,107 | 817,328 | 22,943 | 1,907,458 |
| 1920 | 13,392 | 1,066,807 | 14,169 | 971,510 | 1,553 | 129,993 | 26,008 | 1,908,324 |
| 1921 | 6,339 | 300,595 | 10,601 | 457,993 | 393 | 18,869 | 16,547 | 739,719 |
| 1922 | 6,375 | 368,348 | 16,920 | 757,842 | 291 | 15,910 | 23,004 | 1,110,280 |

## QUICKSILVER MINING INDUSTRY, BY STATES.

*Alaska.*—So far as known, there was no quicksilver mining carried on in Alaska in 1922.

*Arizona.*—Prospecting and development continued in the Phoenix and Mazatzal mountains, Ariz., but no quicksilver was produced.

*California.*—In 1922, as in 1921, the only important mine in California that continued to be worked on anything approaching a normal scale was the Senator mine of the New Almaden Co. (Inc.). The next mine in productive rank was the Cloverdale, from which lessees obtained nearly 900 flasks.

Only 6 operators reported production in California in 1922, as against 7 in 1921. The total production of the State was 3,405 flasks, valued at $196,741. Of this total, 2,817 flasks was obtained directly from furnaces or by retorting furnace soot, 568 flasks was recovered by washing material from the site of demolished reduction works at New Almaden, and 20 flasks came from retorted ore. The output in 1921 was 3,055 flasks, valued at $144,868. The increase was due chiefly to greater activity at the Cloverdale mine. California produced 53 per cent of the total quicksilver output of the country in 1922, as compared with 48 per cent in 1921.

*Quicksilver produced in California, 1850–1922.*

| Year. | Flasks of 75 pounds. | Price per flask. | Value. | Year. | Flasks of 75 pounds. | Price per flask. | Value. |
|---|---|---|---|---|---|---|---|
| 1850–1910 | 2,085,308 | ..... | $93,543,501 | 1918 | 22,664 | $117.50 | $2,663,020 |
| 1911 | 18,860 | $46.01 | 867,749 | 1919 | 15,205 | 90.29 | 1,372,859 |
| 1912 | 20,524 | 42.05 | 863,034 | 1920 | 9,849 | 79.66 | 784,571 |
| 1913 | 15,591 | 40.23 | 627,228 | 1921 | 3,055 | 47.42 | 144,868 |
| 1914 | 11,303 | 49.05 | 554,414 | 1922 | 3,405 | 57.78 | 196,741 |
| 1915 | 14,283 | 85.80 | 1,225,481 | | | | |
| 1916 | 21,045 | 125.89 | 2,649,355 | | 2,265,030 | ..... | 108,013,972 |
| 1917 | 23,938 | 105.32 | 2,521,151 | | | | |

In San Benito County the New Idria mine, in the hands of a receiver, continued to be idle. Near the end of the year plans for a reorganization were completed, and it was expected that this formerly

large producer would again be in operation in the spring of 1923. In Colusa County steps were being taken near the end of the year to reopen the Wide Awake mine, near Wilbur Springs. The Dawson mine, in Kings County, 36 miles from Parkfield, Monterey County, was operated for part of the year by the Patriquin Mining Co. and yielded some quicksilver. In Lake County the usual small output was made by the Wall Street mine, and lessees at the Helen mine produced a few flasks of quicksilver from ore and from soot collected about the furnace. In Monterey County the Patriquin mine, near Parkfield, was leased to the Master Mining Co., which put up a new type of furnace but produced no quicksilver. In Napa County the old Boston or Redington mine, noted for its large yield in early days, was acquired by H. W. Gould and associates and a 20 to 40 ton rotary furnace was set up late in the year. Some development work was done at the Oat Hill mine. In San Luis Obispo County the Oceanic and Carson mines were idle throughout the year. At the Rinconada mine, which has been idle for many years, the equipment and reduction plant were overhauled and two trial runs made in November. In Santa Clara County the Senator mine, as previously noted, was in operation. At the Guadalupe mine some development work was done early in the year, and it was expected that mining would be resumed in 1923 by the Guadalupe Investment Co. In Sonoma County the Cloverdale mine, worked by lessees, made a considerable production, the furnace, a 75-ton rotary, being worked at about half capacity.

*Idaho.*—There was very little activity in quicksilver mining in Idaho in 1922, although some development work was done in the Yellow Pine district, in Valley County.

*Nevada.*—The only recorded production in Nevada was from the Booth and Wardell mine, in the Pilot Mountains, about 12 miles northeast of Mina, in Mineral County. The ore was treated in four D retorts. The mine was operated under lease to the Mina Mercury Co.

*Oregon.*—From the Meadows district, in Jackson County, Oreg., the production of 2 flasks of quicksilver was reported in 1922. There was little activity and no continuous work in progress.

*Texas.*—The Chisos mine, in the Terlingua district, Brewster County, was, as usual of late years, the one large producer in the State of Texas. It was closed for 2½ months for repairs to equipment. The Mariscal mine, south of McKinney Springs, in the same county, was operated, and a relatively large quantity of ore was mined and treated in a new 50-ton Scott furnace. The yield of quicksilver, however, was small, probably because of the usual absorption of mercury in a new furnace of this type and the tendency of the ore, as treated, to yield mercurial soot rather than free quicksilver.

## NOTES ON FOREIGN DEPOSITS.

That the lack of activity in domestic quicksilver mining in 1922 was merely one aspect of a world-wide condition is indicated by the dearth of news concerning foreign deposits.

The Almaden mine in Spain has apparently continued the modernization and improvement of plant and methods but, as elsewhere noted, is not producing at full capacity. The board

of directors of this mine announced on December 20, 1922, that the price of quicksilver had been fixed at 297 pesetas a flask of 34.507 kilograms, less 3½ per cent for cash in advance for delivery at the mine warehouse. Buyers of 1,000 flasks and over, paying cash in advance, are entitled to a further reduction of 6 per cent. Consignees desiring to receive the quicksilver on wagon at Almadenejos Station may do so on payment of 1 peseta a flask, all risks and disbursements, including carriage from the said station, being theirs. Buyers under previous contracts may elect between the terms already agreed upon and the new ones on their so declaring on any new order.

From New Zealand come reports of some activity in the Puhipuhi district, 20 to 30 miles north of Whangarei. The following description of the New Zealand Quicksilver Co.'s mine is extracted from a paper by Black:[2]

Mining operations have shown the quartz which carries the ore to be in the form of a cone, or cones overlapping, typical of hot-spring action, the sides having a dip of 7° to 10°. Levels driven on the ore, therefore, with minor irregularities, tend to curve on the circumference of a circle or ellipse. The whole formation has been buried under basalt and is considerably more extensive than its outcrop would indicate. The ore varies from 3 feet to 8 feet thick. The cone or cones of quartz were apparently deposited free of mercury. Later this quartz sheet was fractured into angular blocks—the writer believes this was due to the weight of the superincumbent basalt; and probably immediately after the eruption of basalt hydrothermal activity recommenced, and this time the liquid carried sulphide of mercury in solution, depositing it in the cracks and filling the larger fractures with ocherous ore, sometimes very high grade, at the same time kaolinizing the surrounding rock.

The mine requires substantial timbering, the country being heavy. The limits of ore have not been reached, either laterally or on the dip. It is estimated there are at least 60,000 tons of ore now opened up, averaging over 1 per cent mercury.

The treatment plant is a Novak coarse-ore furnace, capable of treating 8 tons per day, followed by iron V-shaped condensers, open at the angle and dipping into water a few inches. These are followed by wooden scrubber-box condensers, in which are trays covered with lumps of quartz to baffle the gases, which aid condensation. Between the scrubber boxes and the 12-inch iron exhaust pipe is a fan, driven by a benzine engine, giving the necessary draft through the system.

As the richer, ocherous material crumbles, it can not be treated at the mine, as it chokes the furnace. It is therefore dumped, and thus this most valuable part gives no return at present. The management has under consideration the adoption of Thornhill's wet process for treating these fines; or, alternatively, the erection of a tile furnace as devised for such material. The wet process consists of dissolving the sulphide of mercury in a solution of sodium sulphide and precipitating the mercury with aluminum, the modus operandi being very similar to the cyanide process for gold recovery.

This mine sold £8,000 worth of mercury during the war and recently received a Government bonus of £600 on its production to date.

The discovery has been reported from Japan of a rich quicksilver vein, with a known outcrop of over 7 miles, near the village of Kita Uonome, in the upper Goto Archipelago. The vein is said to be 6 feet wide in places and to yield assays up to 18 per cent of quicksilver. Capitalists in northern Kyushu are planning to develop this vein. Up to the present time such quicksilver deposits as have been found in Japan have been economically unimportant.

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[2] Black, T. A., Mercury in New Zealand: Chem. Eng. and Min. Rev. (Melbourne), Oct. 5, 1922, pp. 17–19.

## RECENT PUBLICATIONS ON QUICKSILVER.

Compiled by ISABEL P. EVANS.

ANDERSON, C. J., Mines statement for the year 1921 (cinnabar): New Zealand Mines Dept. Papers and reports, p. 15, Wellington, 1922. The operations by the New Zealand Quicksilver mines at Puhipuhi were principally in the nature of development. A discovery of cinnabar in the Greenvale survey district was made and is now being prospected.

AUSTRALIA, BUREAU OF CENSUS AND STATISTICS, Official Year Book of the Commonwealth of Australia (mercury), No. 14, 1921, pp. 361–362 [1922]. Mercury was first recorded in New South Wales in 1841. Cinnabar has been found at Bingara; at Silver Creek, in Victoria; at Kilkivan, Wide Bay district, and Mungana, in Queensland; near Willunga, in South Australia; and also in New Guinea.

——— Official Year Book (mercury), No. 15, p. 352, 1922.

BERRY, E. W., and SINGEWALD, J. T., jr., The geology and paleontology of the Huancavelica mercury district: Johns Hopkins Univ. Studies in Geology, No. 2, 91 pp., pls. 6–10, map, 1922. Mercury occurs in Peru along the Andes from Cuzco and Puno, in the south, to the northern departments. The Huancavelica Department is the only one that has furnished a large output, and the Chonta deposit, in the Huanuco Department, is the only other at which there has been a regular production.

BLACK, T. A., Mercury in New Zealand: Chem. Eng. and Min. Rev., Melbourne, vol. 15, pp. 17–19, Oct. 5, 1922. The commercial deposits of mercury in New Zealand are confined to the Puhipuhi district, from 20 to 30 miles north of Whangarei.

BOYLE, W. F. [Report on quicksilver in San Luis Potosi, Mexico]: U. S. Geol. Survey Cons. file, No. 4015, July 10, 1922. The production of quicksilver in San Luis Potosi for the quarter ended June 30, 1922, was 16,747 pounds, valued at $6,451.10.

BRADLEY, W. W., Quicksilver: Mining in California, August, 1922, pp. 393–397 (from California State Min. Bur. Eighteenth Rept.). Practically all of California's important producers have been shut down since November, 1920, except Senator mine of New Almaden Co., in Santa Clara County, which has been working steadily, and Cloverdale mine, in Sonoma County, operated intermittently. Gives table of quicksilver production in California from 1850 to 1921.

BROOKS, A. H., The Alaskan mining industry in 1920 (quicksilver): U. S. Geol. Survey Bull. 722, pp. 23–24, 57, 60, 1922. The reported cinnabar-bearing lode on Montana Creek, near Iditarod, has not yet been examined by any member of the Geological Survey.

——— The Alaskan mining industry in 1921 (quicksilver): U. S. Geol. Survey Bull. 739, p. 13, 1922. Quicksilver was produced in Alaska in 1921 only from cinnabar-bearing lodes on Montana Creek, a tributary of the upper Iditarod. This locality has not been visited by the Geological Survey.

BURCHAM, W. D., Quicksilver: Min. Industry, vol. 30, pp. 607–611, 1922. Summary of production, costs, exports, imports, prices, and tariff during 1921.

CALIFORNIA STATE MINING BUREAU, A review of mining in California during 1921, with notes on the outlook for 1922: Prel. Rept., No. 8, p. 20, January, 1922. Development work is being carried on by the Goose Lake Gold Mining Co., which is opening up a quicksilver deposit in Modoc County. At the Great Northern mine, in Siskiyou County, 200 tons of quicksilver ore was taken out from September, 1920, to February, 1921.

——— Mining in California (quicksilver), p. 32, January, 1922. The output of quicksilver in California in 1921 was the lowest in the history of that metal in California, owing directly to the competiton of cheaper foreign metal imported from Spain and Italy.

CATHCART, S. H., Metalliferous lodes in southern Seward Peninsula (mercury): U. S. Geol. Survey Bull. 722, p. 185, 1922. Cinnabar is found in placer concentrates near Bluff, at Koyana Creek, and at Budd Creek, in the Port Clarence precinct, and is reported from other localities. No details of the occurrence at Bluff are known.

COLLINS, W. F., Mineral enterprise in China (mercury), pp. 67–68, Tientsin, 1922. The Anglo-French Quicksilver Co. undertook mining operations in the Province of Kweichow and in spite of inability to procure explosives made considerable profits for a time, but on the outbreak of the Chinese revolution in 1911 the mines were abandoned.

CROPP, W. H., The genesis of the Puhipuhi cinnabar deposits; a working hypothesis: New Zealand Jour. Sci., vol. 5, No. 3, pp. 173–177, geol. sketch map, July, 1922. Explains the quicksilver deposits as occurring in a layer of siliceous sinter, probably not over 30 feet thick. The deposition of this material was followed by the accumulation of a layer of marcasite from a few inches to several feet in thickness. Subsequently basalt flows were poured out.

ECONOMIC REVIEW (London), The home consumption of mercury in 1921: Vol. 5, No. 16, p. 317, Feb. 24, 1922. [Quoted from España económica y financiera, Jan. 21, 1922.] "According to statistics published by the Gaceta (official Government organ), the total amount of mercury supplied by the State mines of Almaden to national industries was 550 flasks of an aggregate value of pes. 156,974" [£6,540, 11s. 8d.].

FAR EASTERN REPUBLIC, Mineral resources (mercury), p. 45. Special delegation of Far Eastern Republic, Washington, D. C., 1922. Thin cinnabar veins occur in Zabaikal Province, at the sources of the River Serny Ildikan, of which mining was abandoned in 1797; in the silt of the Khorogovochi stream, the left tributary of Amazara River; and at the source of the Katall and Daragon streams, 60 versts south of Nerchinsky works.

FERMOR, L. L., General report of the Geological Survey for the year 1921 (mercury); India Geol. Survey Rec., vol. 54, pt. 1, p. 26, 1922. Cinnabar has been found in the sands of Chitral River. This occurrence is of great interest to the State, and the deposit that forms the source of the cinnabar will be carefully searched for during the present field season.

FERRAR, H. T., and CROPP, W. H., Mineral resources of the Whangarei-Bay of Islands subdivision (cinnabar): New Zealand Geol. Survey Sixteenth Ann. Rept. (new ser.), p. 15, 1922. A considerable quantity of workable cinnabar ore has been discovered at Mount Mitchell, in the Puhipuhi district, and is now being developed.

FORBUS, S. B., French dependence on foreign countries for mercury * * * needed principally for purposes of national defence: U. S. Geol. Survey Cons. file, No. 3992, July 8, 1922. France possesses no deposits of mercury. All of this metal she consumes is imported from other countries.

GASTELUMENDI, A. G., Huancavelica como región productora de mercurio: Lima Cong. nac. indust. min. Anales, vol. 2, pt. 2, pp. 39–69, pl. 2, 1921. The cinnabar ore at its best contains 82.2 per cent of the metal and 13.8 per cent of sulphur; generally it is mixed with bituminous materials, especially in sandstone, forming dark spots; it is also accompanied by realgar (sulphide of arsenic), iron pyrites, zinc, and lead.

GOULD, H. W., Quicksilver mining: Eng. and Min. Jour., vol. 113, p. 87, Jan. 21, 1922. The decline in the domestic quicksilver industry is due primarily to large importations of the metal from Europe in the last six months of 1920 and the first nine months of 1921.

——— The marketing of quicksilver: Eng. and Min. Jour.-Press, vol. 114, No. 24, pp. 1032–1034, 4 figs., Dec. 9, 1922. The principal production of quicksilver comes from Italy and Spain. United States must compete against cheap foreign output.

HENDERSON, J., Cinnabar in New Zealand: New Zealand Geol. Survey Sixteenth Ann. Rept. (new ser.), pp. 15–16, 1922. Names the localities in which cinnabar occurs. The most valuable deposits are in North Auckland.

IMPERIAL MINERAL RESOURCES BUREAU (London), The mineral industry of the British Empire and foreign countries, war period.—Quicksilver (1913–1919), 39 pp., 1922. Cinnabar has been found in Rhodesia, Union of South Africa, Canada (British Columbia), Australia, and New Zealand, but not in commercial quantities.

INDUSTRIAL AUSTRALIAN AND MINING STANDARD (Melbourne), Mineral and industrial resources of Papua (cinnabar): Vol. 67, pp. 241–242, Feb. 9, 1922. Sulphide of mercury or quicksilver has been found in small quantities in four different parts of the Territory.

KELLOGG, A. E., Quicksilver in southern Oregon: Min. and Sci. Press, vol. 124, No. 12, pp. 411–413, 2 figs., March 25, 1922. Describes the Gold Hill district and particularly the War Eagle mine.

KIRSOPP, JOHN, The mineral resources of the Near East (mercury): Near East, London, vol. 16, No. 433, p. 205, Aug. 22, 1919. "Ancient workings for mercury exist in several places near Konia (Turkey). Quicksilver is obtained in the district of Ekaterinoslav in South Russia, the deposits being first worked in 1885."

MEGGLE, ARMAND, Le domaine colonial de la France (le mercure), pp. 48–49, 255, 322, Paris, 1922. Reports the occurrence of mercury in Algeria, French Guiana, and New Caledonia.

MERTIE, J. B., jr., The occurrence of metalliferous deposits in the Yukon and Kuskokwim regions, Alaska (quicksilver): U. S. Geol. Survey Bull. 739, pp. 149–165, 1922. Quicksilver has been produced on a commercial scale in interior Alaska and is connected with granitic intrusive rocks.

MINING AND SCIENTIFIC PRESS, Quicksilver mining in China [abstract of paper by F. Trythall in Cornish Inst. Eng. Trans.]: Vol. 124, No. 11, pp. 371–372, March 18, 1922. The quicksilver ore occurs impregnating well-defined beds of limestone; along the joints, cracks, and planes of stratification; and in isolated bunches, nests, or pockets.

MINING JOURNAL (London), New quicksilver policy in Spain: Vol. 134, pp. 24–25, Jan. 14, 1922. When the Rothschild contract expired, which gave that firm exclusive rights for the sale of the Almaden quicksilver, the Spanish Government decided for the future to reserve the monopoly to itself.

NEAR EAST (London), The Slovenes (mercury): Vol. 20, pp. 419–420, Oct. 6, 1921. States that the people of Slovenia are engaged principally in mining, especially for coal and mercury. Does not give definite localities.

NEW ZEALAND GEOL. SURVEY [cinnabar]: Fourteenth Ann. Rept. (new ser.), pp. 5, 12, 1920. "The Puhipuhi cinnabar mine seems to be of a promising nature, but in practically all mercury mines the ore occurrences are notoriously patchy, and this mine is not likely to be an exception to the rule."

ORCHARD, J. E., Mercury: Political and commercial control of the mineral resources of the world, No. 35, p. 34, Interior Dept., Oct. 28, 1918. Most important and productive quicksilver mines in Mexico are in State of San Luis Potosi. Other deposits of mercury minerals occur in Guerrero, Zacatecas, Chihuahua, Durango, Jalisco, Sonora, and Nayarit (Tepic).

PETRÓLEOS Y MINAS, Venta libre del azogue en España, decreto del Ministerio de Hacienda: Año 2, No. 10, p. 16, March 15, 1922. The contract with Rothschild & Sons, London, issued in 1911 for 10 years, by which they held a commission on the sale of quicksilver from the Almaden mines, having expired on Dec. 31, 1921, the Secretary of the Treasury has issued a decree for the free sale of quicksilver in Spain.

RANSOME, F. L., Mercury: Political and commercial control of the mineral resources of the world, No. 4, 30 pp., Interior Dept., June 30, 1918. Discusses the uses of mercury, its geologic and geographic distribution, developments and changes in the near future, political and commercial control, and international relations.

SCHOFIELD, S. J., The ore deposits of British Columbia (mercury): Canadian Inst. Min. Met. Trans., vol. 24, p. 95, 1922. "The exact age of the mercury deposits which occur in several localities throughout British Columbia is doubtful, but all observers assign them to the Tertiary."

SCHUETTE, C. N., The birth of mercury ores: Eng. and Min. Jour.-Press, vol. 114, pp. 228–229, Aug. 5, 1922. In quicksilver deposits two factors occur, namely, a porous or brecciated rock and an overlying impervious cap rock limiting or directing the upward flow of the mineralizing solutions.

SOUTH AND EAST AFRICAN YEARBOOK, Minerals of South Africa (quicksilver): Vol. 28, p. 355, 1922. Cinnabar has been discovered in the Transvaal—in Marico, on the west, and at Komatipoort, on the east. Reports of its discovery near Capetown and in Griqualand West are doubted.

TEGENGREN, F. R., The quicksilver deposits of China: China Geol. Survey Bull. 2, 36 pp., 7 pls. (incl. maps), October, 1920. The occurrence of quicksilver in China is confined mainly to the Provinces of Kweichow, Szechwan, and Hunan, in the northeast, and Yunnan, in the southwest. Gives detailed information about character of deposits, methods of mining, metallurgy, trade, uses, statistics, and outlook.

TING, V. R., and WONG, W. H., General statement on the mining industry (mercury): China Geol. Survey Special Rept. No. 1, pp. 32–33, June, 1921. The scattered distribution of mercury is confined to the five Provinces of Kweichow, Hunan, Szechwan, Yunnan, and Kwangsi. The ore is of a low grade, and the mercury content seldom more than 3 per cent.

WONG WEN-HAO, The mineral resources of China (metals and nonmetals except coal) (mercury): China Geol. Survey Mem., ser. B, No. 1, p. v, July, 1919. The provinces from which mercury is reported are Szechwan, Hunan, and Kweichow.

# PLATINUM AND ALLIED METALS.

By James M. Hill.

## PRODUCTION.

### CRUDE PLATINUM.

Mine returns for 1922 indicate a production of 39 troy ounces of crude placer platinum in Alaska, 916 ounces in California, and 53 ounces in Oregon, a total of 1,008 ounces for the United States. Comparable figures for 1921 are: Alaska, 65 ounces; California, 821 ounces; Oregon, 91 ounces.

Platinum refiners report purchases of domestic platinum in 1922 as follows: Alaska, 41 ounces; California, 918 ounces; Oregon, 95 ounces; Washington, 4 ounces—a total of 1,058 ounces, which is 37 ounces more than was purchased by refiners in 1921. Refiners also report purchases of 63,482 ounces of foreign crude platinum in 1922—12 ounces from Canada, 53,385 ounces from Colombia, and 10,085 ounces from Russia. As reported by the Bureau of Foreign and Domestic Commerce, Department of Commerce, the imports of platinum from Colombia during 1922 were 37,230 ounces and the total imports of unmanufactured platinum 94,591 ounces.

### REFINED PLATINUM METALS.

#### NEW METALS.

Reports of refiners of crude platinum, gold bullion, nickel, and copper indicate that 57,718 ounces of platinum metals were recovered from these sources in 1922, an increase of 1,348 ounces, as compared with recoveries in 1921.

*New platinum metals recovered by refiners in the United States in 1918–1922, in troy ounces.*

| Year. | Platinum. | Palladium. | Iridium. | Osmiridium. | Other. | Total. |
|---|---|---|---|---|---|---|
| 1918 | 54,399 | 4,024 | 465 | 539 | 326 | 59,753 |
| 1919 | 40,220 | 3,807 | 401 | 402 | 279 | 45,109 |
| 1920 | 36,015 | 4,309 | 418 | 409 | 393 | 41,544 |
| 1921 | 51,791 | 2,686 | 286 | 581 | 1,026 | 56,370 |
| 1922 | 54,142 | 1,943 | 210 | 1,301 | 122 | 57,718 |

Of the total quantity of new platinum metals recovered in 1922, it is estimated that 3,373 ounces can be safely assumed to have been derived from domestic sources.

*New platinum metals recovered by refiners in the United States in 1921–1922, by sources, in troy ounces.*

| Source. | Platinum. | Palladium. | Iridium. | Osmiridium. | Other. | Total. |
|---|---|---|---|---|---|---|
| **1921.** | | | | | | |
| Domestic: | | | | | | |
| Crude | 580 | 3 | 99 | 119 | 12 | 813 |
| Ore | 1 | 492 | | | | 493 |
| Gold and copper refining | 2,318 | 1,165 | 11 | | | 3,494 |
| | 2,899 | 1,660 | 110 | 119 | 12 | 4,800 |
| Foreign: | | | | | | |
| Crude | 46,973 | 302 | 110 | 462 | 758 | 48,605 |
| Gold and copper refining | 1,919 | 724 | 66 | | 256 | 2,965 |
| | 48,892 | 1,026 | 176 | 462 | 1,014 | 51,570 |
| Total recovery | 51,791 | 2,686 | 286 | 581 | 1,026 | 56,370 |
| **1922.** | | | | | | |
| Domestic: | | | | | | |
| Crude | 297 | | 71 | 512 | 11 | 891 |
| Gold and copper refining | 1,701 | 777 | 4 | | | 2,482 |
| | 1,998 | 777 | 75 | 512 | 11 | 3,373 |
| Foreign: | | | | | | |
| Crude | 51,764 | 525 | 114 | 789 | 7 | 53,199 |
| Gold, nickel, and copper refining | 380 | 641 | 21 | | 104 | 1,146 |
| | 52,144 | 1,166 | 135 | 789 | 111 | 54,345 |
| Total recovery | 54,142 | 1,943 | 210 | 1,301 | 122 | 57,718 |

## SECONDARY METALS.

Secondary platinum metals are those recovered from the treatment of scrap metal, sweeps, and other waste products of manufacture that contain platinum. Although the figures given in the following table undoubtedly contain some duplication, it is believed that they are of importance, for the secondary metals constitute a considerable item—22 per cent in 1922—of the total platinum metals available for consumption in the United States:

*Secondary platinum and allied metals recovered in the United States in 1918-1922, in troy ounces.*

| Year. | Platinum. | Palladium. | Iridium. | Total. |
|---|---|---|---|---|
| 1918 | 40,378 | 1,795 | 3,410 | 45,583 |
| 1919 | 54,545 | 3,467 | 3,504 | 61,516 |
| 1920 | 51,255 | 3,100 | 3,355 | 57,710 |
| 1921 | 39,131 | 4,887 | 1,776 | 45,794 |
| 1922 | 40,062 | 4,193 | 1,937 | 46,192 |

## IMPORTS AND EXPORTS.[1]

The imports of platinum and allied metals for consumption in 1922 were approximately 40 per cent greater in quantity than in 1921 and 9 per cent greater than in 1920.

[1] The data for imports and exports were compiled by J. A. Dorsey, of the U. S. Geological Survey, from the records of the Bureau of Foreign and Domestic Commerce, Department of Commerce.

*Platinum and allied metals imported for consumption in the United States, 1921-22.*

| Metal. | 1921 | | 1922 | |
|---|---|---|---|---|
| | Troy ounces. | Value. | Troy ounces. | Value. |
| Platinum or crude platinum and unmanufactured products, ingots, bars, sheets, wire, etc | 62,097 | $4,129,639 | 94,939 | $7,790,898 |
| Platinum, manufactured products, vases, retorts, etc | 63 | [a] 14,120 | 18 | [a] 9,548 |
| Iridium | 1,345 | 277,597 | 1,899 | 298,567 |
| Osmiridium | 2,603 | 296,277 | 2,165 | 242,637 |
| Osmium | 161 | 13,239 | 1,012 | 81,231 |
| Palladium | 11,348 | 629,965 | 9,754 | 537,684 |
| Rhodium | 609 | 53,359 | 111 | 16,227 |
| Ruthenium | 152 | 4,268 | 100 | 4,839 |
| | 78,378 | 5,418,464 | 109,998 | 8,981,631 |

[a] Includes articles to the value of $6,947 in 1921 and $6,735 in 1922, imported under duty, quantity not given.

*Platinum imported into the United States in 1922, by countries.*

[General imports.]

| Country. | Unmanufactured. | | Vases, retorts, etc. | | All other manufactures. |
|---|---|---|---|---|---|
| | Troy ounces. | Value. | Troy ounces. | Value. | |
| Argentina | 64 | $5,919 | | | |
| Australia | 36 | 2,160 | | | |
| Austria | 3 | 384 | | | $36 |
| Brazil | 110 | 8,031 | | | |
| British Honduras | 55 | 5,000 | | | |
| Canada | 186 | 14,670 | | | 228 |
| Chile | 34 | 3,392 | | | |
| Colombia | 37,230 | 2,926,487 | | | |
| Cuba | 20 | 1,801 | | | |
| Denmark | 6 | 489 | | | |
| Ecuador | 2 | 198 | | | |
| England | 34,994 | 2,840,755 | | | 41,423 |
| Esthonia | 6,448 | 513,971 | | | |
| France | 11,396 | 1,082,294 | 7 | $662 | 6,245 |
| Germany | 1 | 85 | 3 | 392 | 1,988 |
| Italy | 11 | 675 | | | |
| Latvia | 28 | 2,369 | | | |
| Mexico | 422 | 38,635 | | | |
| Netherlands | 70 | 5,545 | 8 | 1,759 | |
| New Zealand | | | | | 67 |
| Norway | 96 | 7,401 | | | |
| Panama | 92 | 10,429 | | | |
| Scotland | 20 | 2,280 | | | |
| Spain | 40 | 3,360 | | | |
| Sweden | 3,158 | 269,939 | | | |
| Switzerland | | | | | 105 |
| Turkey in Europe | 13 | 1,363 | | | |
| Uruguay | 49 | 1,310 | | | |
| Venezuela | 7 | 515 | | | |
| | 94,591 | 7,749,457 | 18 | 2,813 | 50,092 |

In the foregoing table unmanufactured platinum imported from Colombia is crude, and the imports from Esthonia, Latvia, and Sweden are believed to be crude platinum of Russian origin. Part of the platinum from England and France is doubtless Russian crude, but the bulk is probably refined metal.

*Platinum exported from the United States, 1918–1922.*

| Year. | Unmanufactured. | | Manufactures of, except jewelry. | |
|---|---|---|---|---|
| | Troy ounces. | Value. | Troy ounces. | Value. |
| 1918 | 119 | $13,511 | (a) | $23,562 |
| 1919 | 522 | 75,066 | (a) | 54,529 |
| 1920 | 1,302 | 177,115 | (a) | 111,014 |
| 1921 | 3,272 | 244,473 | 741 | 85,216 |
| 1922 Crude, scrap, and old | 143 | 13,149 | 486 | 35,967 |
| 1922 Ingots, sheets, wire, and alloys | 1,313 | 127,047 | | |

a Quantity not given.

## CONSUMPTION.

The consumption of the chief platinum metals in the United States in 1922, as reported by refiners, was 181,498 ounces, an increase of 3 per cent from 1921. The electrical industry used less palladium than in 1921 but more platinum and iridium. The dental industry was apparently overstocked from the previous year and reduced its consumption of platinum and palladium. In the jewelry industry there was an increased consumption of all platinum metals, but the greatest increase was in palladium, presumably for the manufacture of the so-called "white gold" alloys.

Osmium is being used in increasing amounts for the preparation of an alloy that is substituted for native osmiridium for pointing gold pens, and it is rumored that some osmium is being used as a hardener for platinum in place of the more expensive iridium.

It has been found impossible to reconcile the consumption of 181,498 ounces of the chief platinum metals, as given by refiners, with the apparent consumption of 135,933 ounces, as calculated in the second table below or by any variants of that method. It is believed that there is considerable duplication in the figures for consumption given by refiners, but so far no means have been found to avoid this source of error, and the figures supplied by refiners give the only measure of consumption by industries. In the second method of calculation there is a source of error in the assumption of the quantity of platinum imported in the refined state. Nevertheless, this method is believed to give a fair measure of the quantity of platinum metals consumed. It seems probable that the actual consumption was about 150,000 ounces.

*Chief platinum metals consumed in the United States as reported by refiners, 1921–22, by industries, in troy ounces.*

| Industry. | Platinum. | Iridium. | Palladium. | Total. | Percentage of total. |
|---|---|---|---|---|---|
| **1921.** | | | | | |
| Chemical | 12,273 | 34 | 45 | 12,352 | 7.01 |
| Electrical | 20,574 | 1,003 | 7,626 | 29,203 | 16.58 |
| Dental | 13,181 | 75 | 8,501 | 21,757 | 12.35 |
| Jewelry | 101,258 | 2,367 | 1,265 | 104,890 | 59.55 |
| Miscellaneous | 3,791 | 3,938 | 217 | 7,946 | 4.51 |
| | 151,077 | 7,417 | 17,654 | 176,148 | 100.00 |
| **1922.** | | | | | |
| Chemical | 8,834 | 172 | 458 | 9,464 | 5.21 |
| Electrical | 24,988 | 1,537 | 2,735 | 29,260 | 16.12 |
| Dental | 11,651 | 83 | 5,535 | 17,269 | 9.52 |
| Jewelry | 108,527 | 2,588 | 9,852 | 120,967 | 66.65 |
| Miscellaneous | 2,838 | 1,064 | 636 | 4,538 | 2.50 |
| | 156,838 | 5,444 | 19,216 | 181,498 | 100.00 |

*Apparent supply of chief platinum metals in the United States in 1921–22, in troy ounces.*

| | Platinum. | Iridium. | Palladium. | Total. |
|---|---|---|---|---|
| **1921.** | | | | |
| Stocks Jan. 1, 1921 | 46,747 | 4,196 | 16,565 | 67,508 |
| New metal produced, 1921 | 51,791 | 286 | 2,686 | 54,763 |
| Secondary metal produced, 1921 | 39,131 | 1,776 | 4,887 | 45,794 |
| Imports | [a] 5,432 | 3,948 | 11,348 | 20,728 |
| Total available | 143,101 | 10,206 | 35,486 | 188,793 |
| Stocks Jan. 1, 1922 | 38,514 | 4,991 | 21,042 | 64,547 |
| Apparent supply | 104,587 | 5,215 | 14,444 | 124,246 |
| Exports | 4,013 | | | 4,013 |
| Apparent domestic consumption | 100,574 | 5,215 | 14,444 | 120,233 |
| **1922.** | | | | |
| Stocks Jan. 1, 1922 | 38,514 | 4,991 | 21,042 | 64,547 |
| New metal produced, 1922 | 54,142 | 210 | 1,943 | 56,295 |
| Secondary metal produced, 1922 | 40,062 | 1,937 | 4,193 | 46,192 |
| Imports | [a] 31,457 | 4,064 | 9,754 | 45,275 |
| Total available | 164,175 | 11,202 | 36,932 | 212,309 |
| Stocks Jan. 1, 1923 | 41,900 | 7,559 | 24,975 | 74,434 |
| Apparent supply | 122,275 | 3,643 | 11,957 | 137,875 |
| Exports | 1,942 | | | 1,942 |
| Apparent domestic consumption | 120,333 | 3,643 | 11,957 | 135,933 |

[a] Platinum "imported for consumption" less crude foreign platinum purchased by refiners is taken to be refined platinum imported.

## STOCKS.

Stocks of the chief platinum metals in the hands of refiners on December 31, 1922, amounted to 74,434 ounces, an increase of 15 per cent as compared with the stocks at the beginning of the year.

*Stocks of chief platinum metals on hand in the United States December 31, 1918–1922, in troy ounces.*

| Metal. | 1918 | 1919 | 1920 | 1921 | 1922 |
|---|---|---|---|---|---|
| Platinum | 51,504 | 29,228 | 46,747 | 38,514 | 41,900 |
| Iridium | 3,224 | 3,359 | 4,196 | 4,991 | 7,559 |
| Palladium | 10,086 | 10,235 | 16,565 | 21,042 | 24,975 |
| | 64,814 | 42,822 | 67,508 | 64,547 | 74,434 |

## MARKET AND PRICES.

### CRUDE PLATINUM.

Sellers of domestic crude platinum reported having received from $78 to $102 an ounce for their product in 1922, and the average for all crude platinum reported was $98 an ounce. Buyers reported purchases at a rate of $85 to $90 an ounce for domestic and $70 to $95 for foreign crude platinum. Buyers of foreign and domestic crude platinum in the United States who reported purchases in 1922 are listed below:

American Platinum Works, 325 New Jersey Railroad Avenue, Newark, N. J.
Baker & Co. (Inc.), Murray and Austin streets, Newark, N. J.
J. Bishop & Co., Malvern, Pa.
Sigmund Cohn, 44 Gold Street, New York, N. Y.
Goldsmith Bros. Smelting & Refining Co., 20 John Street, New York, N. Y.

S. B. Gracier (Inc.), 608 Commercial Street, San Francisco, Calif.
Martin Hannum Refining Co. (Pacific Platinum Works), 814 South Spring Street, Los Angeles, Calif.
Interstate Smelting & Refining Co., 29 Commercial Street, Newark, N. J.
Kastenhuber & Lehrfeld, 24 John Street, New York, N. Y.
National Smelting & Refining Co., 92 John Street, New York, N. Y.
R. & H. Platinum Works, 709 Sixth Avenue, New York, N. Y.
Shreve & Co., Post and Grant streets, San Francisco, Calif.
Wildberg Bros., 742 Market Street, San Francisco, Calif.
H. A. Wilson Co., 97 Chestnut Street. Newark, N. J.

## REFINED METALS.

The quoted prices [2] for refined platinum remained within the limits of $80 to $118 an ounce throughout the year; they were below $90 until the middle of the year and then rose to $118, and it is believed that the average selling price was $102. Iridium began the year at $160 an ounce but rose to $180 early in February, suffered a slight decline in the middle of the year, rose to $300 in October, and closed the year at $260; the average selling price was approximately $245. Palladium was steady throughout the year at $55 an ounce.

The 5 per cent iridium alloy sold at an average of $108 an ounce, and the 10 per cent alloy at $116 an ounce; the highest prices reached were $126 and $134, and the lowest $88 and $94, respectively.

## TARIFF.

Crude materials carrying the platinum metals may be imported free of duty under the tariff of 1922, as shown by the following paragraphs quoted from title 11, Free list:

PAR. 1596. Iridium, osmium, palladium, rhodium, and ruthenium and native combinations thereof with one another or with platinum.

PAR. 1634. Ores of gold, silver, or nickel; nickel matte; ores of platinum metals; sweepings of gold and silver.

PAR. 1644. Platinum, unmanufactured or in ingots, bars, sheets, or plates not less than one-eighth of one inch in thickness, sponge, or scrap.

Manufactured articles in which platinum is used are subject to import duties, as shown by the following paragraphs from title 1, Dutiable list:

PAR. 21. Chemical compounds, mixtures, and salts, of which gold, platinum, rhodium, or silver constitutes the element of chief value, 25 per centum ad valorem.

PAR. 309. All iron or steel sheets, plates, bars, and rods, and all hoop, band, or scroll iron or steel, excepting what are known commercially as tin plates, terneplates, and taggers tin, when galvanized or coated with zinc, spelter, or other metals, or any alloy of those metals, shall pay two-tenths of 1 cent per pound more duty than if the same was not so galvanized or coated; sheets or plates composed of iron, steel, copper, nickel, or other metal with layers of other metal or metals imposed thereon by forging, hammering, rolling, or welding, 30 per centum ad valorem; thermostatic metal in sheets, plates, or other forms, 50 per centum ad valorem; sheets and plates of iron or steel, polished, planished, or glanced, by whatever name designated, 1¼ cents per pound: *Provided*, That plates or sheets of iron or steel, by whatever name designated, other than polished, planished, or glanced, herein provided for, which have been pickled or cleaned by acid, or by any other material or process, or which are cold-rolled, smoothed only, not polished, shall pay two-tenths of 1 cent per pound more duty than the rates provided on corresponding thicknesses of common or black sheet iron or steel.

PAR. 318. Woven-wire cloth: Gauze, fabric, or screen, made of wire composed of steel, brass, copper, bronze, or any other metal or alloy, not specially provided for,

[2] Eng. and Min. Jour.-Press, vols. 113, 114, 1922.

with meshes not finer than thirty wires to the lineal inch in warp or filling, 25 per centum ad valorem; with meshes finer than thirty and not finer than ninety wires to the lineal inch in warp or filling, 35 per centum ad valorem; with meshes finer than ninety wires to the lineal inch in warp or filling, 45 per centum ad valorem.

PAR. 353. Fountain pens, fountain-pen holders, stylographic pens, and parts thereof, 72 cents per dozen and 40 per centum ad valorem; *Provided*, That the value of cartons and fillers shall be included in the dutiable value.

PAR. 399. Articles or wares not specially provided for, if composed wholly or in chief value of platinum, gold, or silver, and articles or wares plated with platinum, gold, or silver, or colored with gold lacquer, whether partly or wholly manufactured, 60 per centum ad valorem; if composed wholly or in chief value of iron, steel, lead, copper, brass, nickel, pewter, zinc, aluminum, or other metal, but not plated with platinum, gold, or silver, or colored with gold lacquer, whether partly or wholly manufactured, 40 per centum ad valorem.

PAR. 1428. Jewelry, commonly or commercially so known, finished or unfinished, of whatever material composed, valued above 20 cents per dozen pieces, 80 per centum ad valorem; rope, curb, cable, and fancy patterns of chain not exceeding one-half inch in diameter, width, or thickness, valued above 30 cents per yard; and articles valued above 20 cents per dozen pieces, designed to be worn on apparel or carried on or about or attached to the person, such as and including buckles, cardcases, chains, cigar cases, cigar cutters, cigarette holders, coin holders, collar, cuff, and dress buttons, combs, match boxes, mesh bags and purses, millinery, military and hair ornaments, pins, powder cases, stamp cases, vanity cases, and like articles; all the foregoing and parts thereof, finished or partly finished, composed of metal, whether or not enameled, washed, covered, or plated, including rolled gold plate, and whether or not set with precious or semiprecious stones, pearls, cameos, coral, or amber, or with imitation precious stones or imitation pearls, 80 per centum ad valorem; stampings, galleries, mesh, and other materials of metal whether or not set with glass or paste, finished or partly finished, separate or in strips or sheets, suitable for use in the manufacture of any of the foregoing articles in this paragraph, 75 per centum ad valorem.

## WORLD'S PRODUCTION.

*Estimated world's production of crude platinum from placers, 1913–1921, in troy ounces.*

| Country.[a] | 1913 | 1914 | 1915 | 1916 | 1917 | 1918 | 1919 | 1920 | 1921 |
|---|---|---|---|---|---|---|---|---|---|
| Australia:[a] | | | | | | | | | |
| New South Wales[b] | 442 | 244 | 56 | 82 | 259 | 607 | 213 | 796 | 249 |
| Tasmania[c] | 1,262 | 1,019 | 247 | 222 | 332 | 1,607 | 1,670 | 2,009 | 1,751 |
| British India[d] | 58 | 37 | 18 | 9 | 4 | (*e*) | | | |
| Canada[f] | 50 | 30 | 100 | 60 | 80 | 40 | 30 | 25 | 15 |
| Colombia[g] | 15,000 | 17,500 | 18,000 | 25,000 | 32,000 | 35,000 | 35,000 | 35,000 | 35,500 |
| Japan[h] | | | | | | | 155 | 258 | 255 |
| Papua[i] | | | | | | | | 100 | 360 |
| Russia[g] | 250,000 | 241,200 | 124,000 | 63,900 | 50,000 | 25,000 | 30,000 | 35,000 | 20,000 |
| United States | 483 | 570 | 742 | 750 | 605 | 647 | 824 | 613 | 977 |

[a] In addition to the countries listed below, Victoria, Australia, reports 127 ounces for 1913. In 1915 Brazil exported 700 grams (23 ounces).
[b] New South Wales Dept. Mines Ann. Repts.
[c] Tasmania Dept. Mines Ann. Repts. Tasmanian production all osmiridium.
[d] India Geol. Survey Rec.
[e] Production 0.31 ounce.
[f] Estimate by J. M. Hill; Canada Dept. Mines Ann. Repts. give the following figures (believed low), 1913, 13; 1914, none; 1915, 23; 1916, 15; 1917, 57; 1918, 39; 1919, 25; 1920, 17.
[g] Estimate by J. M. Hill.
[h] 1919–1920, figures furnished by American embassy, Tokyo; 1921, consular report, Sept. 1, 1922.
[i] Territory of Papua Mines Dept. Rept. Production osmiridium, year ending June 30.

## PLATINUM DEPOSITS.

### UNITED STATES.

In California about the usual quantities of platinum and osmiridium were recovered, the largest output coming from the dredges at the base of the Sierra and in Shasta and Trinity counties. A number of men were working with fair results on Peanut Fork of Cottonwood Creek, in northern Tehama County, and on Hay Fork of Trinity River, in the vicinity of Platina. Some details of the

methods used by the dredge companies for saving platinum and rusty gold in their black sands have been published.[3]

The United States Bureau of Mines[4] has shown that the Beam American continuous retort process for "unlocking" gold and platinum in shale is unworkable for that purpose and that the Colorado shale does not carry precious metals in sufficient quantities to be of commercial significance.

Idaho has been through the throes of a platinum excitement, based on assayers' reports of the occurrence of platinum metals at the Home Builder, Caribou, and Wilson United mines, near Coeur d'Alene. The affair was given considerable publicity, as a result of which Federal and State agencies undertook an investigation,[5] which showed conclusively that platinum is not present in the ores at any of the properties. The local operators are believed to have been misled by certain so-called assayers, who formerly operated at Grants Pass, Oreg.

The Geological Survey has been informed that a little platinum is found in placers in the Troy district, Lincoln County, Mont., and that a copper-nickel ore from a property at Contact, in Park County, carries appreciable amounts of platinum.

All the platinum produced in Oregon in 1922, a total of 53 ounces, came from the southwestern counties, and the greater part from the beach mines in the vicinity of Bullards, Port Orford, Sixes, and Wedderburn. So far as reports to the Geological Survey show, no platinum was saved by the dredges in Sumpter Valley, Baker County, and only a small quantity was obtained from the placer mines on Illinois River in Josephine County.

The Electrolytic mine (old Rambler), near Holmes, Albany County, Wyo., owned by the Electrolytic Copper Co., of Council Bluffs, Iowa, was under development during 1922, and late in the year the company shipped ore to eastern smelters. The president of the company states that the mine is now in condition to ship regularly a good-grade copper ore carrying silver, gold, platinum, and palladium. The Iron Blossom Mining Co. owns properties near the Electrolytic mine.

### BRAZIL.

In April[6] announcement was made of the discovery of platinum in the State of Parahyba do Norte, Brazil. Samples of this ore received in the United States consist of a rather siliceous hematite in which, if platinum is present its distribution is probably erratic, for qualitative tests of several pieces did not indicate its presence.

### CANADA.

The production of platinum metals in Ontario[7] in 1922, which represents recoveries from refining part of the Sudbury nickel-copper ores, was 176.18 ounces of platinum, 341.44 ounces of palladium, and

[3] Separating platinum from sand: Eng. and Min. Jour., vol. 113, p. 251, Feb. 11, 1922.
[4] Varley, Thomas, Mines Bureau investigates gold in oil shale and explains methods used to obtain results: Salt Lake Min. Rev., vol. 24, pp. 9–12, Nov. 30, 1922.
[5] A preliminary study of certain reported platinum occurrences near Coeur d'Alene, Idaho: Idaho Bur. Mines and Geology Pamphlet 6, July, 1923.
[6] Commerce Repts., Apr. 13, 1923.
[7] Report of Ontario Minister of Mines, copied in Eng. and Min. Jour.-Press, vol. 115, p. 627, Apr. 7, 1923.

124.44 ounces of rhodium, ruthenium, osmium, and iridium. It is reported that during 1922 a dredge was built on Peace River, near Hudson's Hope, Alberta, to treat sands that are said to carry platinum as well as gold.

## COLOMBIA.

The South American Gold & Platinum Co.,[8] operating on Condoto River and near-by tributaries of San Juan River in Colombia, produced 13,068 ounces of platinum during the first 8 months of 1922. An accident to the No. 1 dredge, an old English-built boat inherited from the Anglo Colombia Co., prevented it from full operation, but the No. 3 dredge was put into commission in December. The company is now installing a hydroelectric plant on Andagueda River, which will supply power for all its operations. Recently acquired tracts of land in the San Juan and Atrato drainage basins will considerably lengthen the life of this platinum-producing company.

The British Platinum & Gold Corporation[9] reports a production for the fiscal year ending July 31, 1922, of 1,885 ounces of platinum, and for the first 18 weeks of the fiscal year beginning August 1, 1922, of 1,400 ounces. The production was all made by the No. 1 dredge, as exceptionally low water delayed the launching of the No. 2 dredge until October 4, and it did not begin digging until December, 1922.

The Colombian Proprietary Gold Mines, Ltd., largely controlled by the British Gold & Platinum Corporation, has its first boat in operation on one of the streams in its holdings, comprising 40 square miles.

It is reported that the Colombian Platinum & Gold Dredging Co. (an American concern) is prospecting holdings in the vicinity of Noanama, on San Juan River, and it is believed that the work so far has demonstrated the advisability of dredge operations.

## FINLAND.

Sederholm[10] reports that small amounts of platinum have been found in the gold placers of Lapland, and that the platinum is believed to have been derived from peridotitic rocks, which are not uncommon in that region.

## JAPAN.

Through the courtesy of Prof. M. Watanabe, of the Tohoku Imperial University, Sendai, Japan, it is possible to give some notes on the occurrence of osmiridium and platinum in Japan. There is little published information in English on these deposits, and only scattered notes in the Journal of the Geological Society of Tokyo, which is printed in Japanese.

Osmiridium and platinum associated with magnetite, chromite, and cinnabar occur in the placers of Yubari-gawa, Pechan, and Usotannai rivers, in the central and northern parts of Hokushu Island, the northern of the Japanese group. The Japanese production of these metals comes from this field. The osmiridium is well crystallized, and the great bulk of the material is from 0.5 to 1 millimeter in size.

[8] Letter to stockholders, dated Oct. 5, 1922.
[9] London Min. Mag., vol. 28, p. 64, advertising p. 31, January, 1923.
[10] Sederholm, J. J., Mineral resources and mining possibilities of Finland: Eng. and Min. Jour., vol. 113, p. 161, January, 1922.

In some of the streams osmiridium forms as much as 65 per cent of the precious-metal content. An analysis of the osmiridium from Kitami Province, Hokushu, made by S. Aoyama, shows the following composition:

| | | | |
|---|---|---|---|
| Iridium | 49.80 | Gold | 0.02 |
| Osmium | 37.30 | Ferric oxide | .76 |
| Ruthenium | 7.69 | Alumina | .03 |
| Rhodium | 3.92 | | |
| Platinum | .15 | | 99.67 |

The placer deposits of Hokushu are in the present river channels and to some extent on the beaches. The bedrocks are of Paleozoic age and contain gold veins. So far, the sources of the platinum have not been located.

On Honshu, the main island of the Japanese group, osmiridium has been found in placers at Tsuyo, in Rikuzen Province, and at Daigo and Keda, in Hitachi Province, on the east coast. Platinum is reported to occur in certain gold placers on Sado Island, west of Honshu, which are found in Tertiary volcanic rocks. On the island of Shikoku osmiridium in moderate amounts has been found in gold placers near Dozangawa and Yamashirodani. In this region there are replacement deposits of chalcopyrite-pyrite ore, and serpentine has been found.

## PAPUA.

E. R. Stanley,[11] Government geologist of Papua, has summarized the results of several years' study of the geology of the east end of the island of New Guinea. He emphasizes the possibility of obtaining oil in certain of the Miocene sediments but makes no mention of the gold and osmiridium placers, though the occurrence of copper deposits is noted. In another article,[12] however, Stanley gives considerable information concerning the location of osmiridium-bearing gravels in the territory. He notes particularly the association of serpentine and osmiridium in the Owen Stanley Range and says: "The main belts of serpentines pass through the headwaters of the Waria to the Gira and Aikora rivers and follow up the right bank of the Yadda in the Ajula-Kujala Range, thence through Oivi into the valley of the Kumusi and along the Little Kumusi (Mamama) River. It is also met with in the Mugoni (Upper Musa) River on the right bank below Balatana village and passes into the country north of Mount Brown." He notes that osmiridium has been found with gold at Milne Bay, Lake Kamu, and Brown River, in the central division.

From recent reports [13] it appears that the Waria River Gold & Platinum Options Syndicate acted on the reported occurrence of placer ground in Papua and believed it had demonstrated the value of a considerable area of gravels in what was formerly German New Guinea. This property has since been examined by British engineers, who report that "the property is valueless." [14]

[11] Stanley, E. R., A contribution to the geology of New Guinea, Papua: Home and Territories Dept. Bull. 7, Melbourne, 1921.
[12] Stanley, E. R., Osmiridium—its occurrence in Papua and the possibilities of its being worked commercially: Papuan Courier, Jan. 30, 1920.
[13] London Min. Mag., vol. 28, pp. 95, 164, February and March, 1923.
[14] Idem, vol. 29, p. 33, July, 1923.

## RUSSIA.

For a time during 1922 it seemed that platinum mining in Russia might be revived as a result of the Urquhart-Krassin negotiations. However, the agreement signed by these gentlemen was not ratified by the soviet government, and Russian mineral resources are still tied up. Announcement was made in July [15] of the organization of the Anglo-Ural Platinum Trust, with representatives of Russian producers and English refiners and consumers on the board of directors. So far as known, this trust has not yet begun operations but will wait for more stable conditions before venturing too much in Russia. Later reports [16] indicated that at least four different agencies are endeavoring to gain a foothold in the Russian platinum field—the Anglo-Ural Platinum Trust, mentioned above; the Anglo-French Ural Syndicate, in which, it is said, the firm of Johnson Matthey, London, is interested through its connection with the Russo-Asiatic Consolidated; the Society for Technical Aid of Soviet Russia; and the soviet government, whose operations with regard to platinum production are said to be under the supervision of Prof. Louis Duparc. That there has been some small production of platinum in the Russian fields seems certain, as the soviet government [17] accounts for some 12,000 ounces, and it is known that a considerable quantity of Russian platinum has left that country by way of Esthonia and Sweden. It is believed, however, that the production was limited to that which could be produced solely by hand work on some of the richest ground and that a large part of the platinum exported in 1922 was taken from stocks of the metal previously mined.

## TASMANIA.

There has been no particular news from the Tasmanian osmiridium fields. The production in 1921 was 1,751 ounces, about 50 ounces less than in 1920, but more than in 1918 or 1919.

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[15] London Min. Jour., vol. 138, p. 522, July 8, 1922.
[16] Idem, p. 713, Sept. 16, 1922.
[17] Econ. Life, Moscow, Aug. 22, 1922; Commerce Repts., Oct. 16, 1922, p. 145.

# SILVER, COPPER, LEAD, AND ZINC IN THE CENTRAL STATES.[1]

(MINES REPORT.)

By J. P. Dunlop and F. Begeman.

## INTRODUCTION.

The silver, copper, lead, and zinc mines of the Central States are in Arkansas, Illinois, Kansas, Kentucky, Michigan, Missouri, Oklahoma, and Wisconsin, The territory thus embraced lies in the great interior valley province of the United States, which extends from Appalachian system to the Rocky Mountain front, exclusive of the Black Hills. Most of the mines are in the Paleozoic sedimentary rocks of this province, but the copper range of northern Michigan comprises lavas and intercalated sediments of pre-Cambrian age.

In the lead and zinc regions of the Central States the material sold is principally concentrates,[2] and payment is made according to a basic price for concentrates of a certain quality. The details of this method are given in the pages devoted to Missouri in this report for 1914. The figures reported to the Geological Survey by producers represent the quantity and assay contents of concentrates sold and the amount received in payment. The total metal produced is calculated from the first two of these items.

The operators in Michigan report the quantity of concentrates produced and the actual recovery of copper from concentrates smelted.

In any year the mines may produce more or less concentrates than are smelted during the same period. The copper content of concentrates produced but not smelted during the year has been estimated on the basis of the average copper recovery per ton for the year of the company producing it.

## TENOR OF LEAD AND ZINC ORES OF THE CENTRAL STATES.

Much of the ore mined in the Western States is crude smelting ore—that is, it can be smelted directly without preliminary concentration. All but a very small portion of the ore from the Central States, however, is of such tenor that it requires concentration. The only fair basis for comparison of the relative magnitude of mining operations in different States is that of quantity of crude ore, or "dirt." In Kentucky and southern Illinois the lead and zinc con-

[1] A bibliography is given in Mineral Resources for 1919 and some preceding volumes.

[2] In local usage the ore as mined is called "dirt" and the concentrates are classed as "ore." Where the capacity of a concentrating plant is given, such capacity is to be understood as based on a 10-hour shift unless otherwise stated.

centrates are recovered as by-products in the concentration of the fluorspar which they accompany, and it was not possible to make calculations of the metal content of the crude ore raised.

*Quantity and tenor of copper, lead, and zinc ores of Central States, 1920–1922.*

| State. | 1920 | | 1921 | | 1922 | |
|---|---|---|---|---|---|---|
| | Crude ore. | Metal content.[a] | Crude ore. | Metal content.[a] | Crude ore. | Metal content.[a] |
| | *Short tons.* | *Per cent.* | *Short tons.* | *Per cent.* | *Short tons.* | *Per cent.* |
| Arkansas | 9,800 | 3.81 | (b) | ..... | (b) | ..... |
| Illinois (northern) | 312,000 | 2.13 | 81,400 | 4.10 | 66,150 | 6.71 |
| Kansas | 1,704,700 | 4.96 | 1,132,000 | 5.26 | 2,151,200 | 4.00 |
| Michigan | 5,938,967 | 1.18 | 3,610,648 | 1.19 | 4,952,264 | 1.23 |
| Missouri | 6,108,030 | 3.15 | 5,302,100 | 3.69 | 5,879,700 | 3.40 |
| Oklahoma | 6,943,100 | 4.46 | 2,969,500 | 5.97 | 6,159,500 | 4.82 |
| Wisconsin | 1,742,000 | 2.08 | 136,300 | 3.78 | 221,000 | 3.90 |
| | 22,758,597 | ..... | 13,231,948 | ..... | 19,429,814 | ..... |

[a] The percentages given in this column represent the metal content of the ore in so far as it is recovered in the concentrates. In Michigan the metal so recovered is copper, in the other Central States the metals are lead and zinc, the relative proportions of which are shown in the table on another page and in the tables of tenor of ore given in the sections devoted to the respective States.

[b] No record of ore treated.

The marked increase in 1922 shown by this table was distributed mainly among the copper mines of Michigan and the lead and zinc mines of Oklahoma and Kansas. Smaller increases in output of lead and zinc ores occurred in Wisconsin and Missouri. The output of disseminated lead ore in southeastern Missouri increased 94,000 tons.

The low average tenor of the crude ore mined in the Central States in 1922 is best shown by the fact that the average value of the total recoverable metal content was only $4.13 a ton of crude ore treated, though this was 29 cents more than in 1921, owing to the higher price of lead and zinc. The 14,477,550 tons of zinc, lead, and lead-zinc ores treated in the Central States exclusive of southern Illinois, Kentucky, and Arkansas in 1922 yielded lead and zinc concentrates which sold for $41,953,178, so that the mine operators realized an average of $2.90 a ton of ore mined and treated, against $2.43 a ton in 1921. The quantity and the value of both lead and zinc concentrates were greater in 1922 than in 1921.

## PRODUCTION.

### GENERAL STATISTICS.

The total value of the mine production of silver, copper, lead, and zinc in the Central States in 1922 was $29,411,142 more than the value for 1921. The total value of the mine production of these metals for the years 1907 to 1922, inclusive, was $1,502,101,098—$568,385,796 for copper, $547,547,894 for zinc, $380,031,712 for lead, and $6,135,696 for silver. Only in 1915, 1916, 1919, 1920, 1921, and 1922 has the value of the recoverable zinc exceeded that of the copper, and in 1922 the value of the lead was nearly double that of copper.

*Mine production of silver, copper, lead, and zinc in the Central States in 1922, by States.*

| State. | Silver. | | Copper. | |
|---|---|---|---|---|
| | Fine ounces. | Value. | Pounds. | Value. |
| Illinois | 6,025 | $6,025 | | |
| Michigan | 376,990 | 376,990 | 121,712,365 | $16,431,169 |
| Missouri | 212,656 | 212,656 | 797,400 | 107,649 |
| Total, 1921 | 595,671 | 595,671 | 122,509,765 | 16,538,818 |
| | 381,974 | 381,974 | 86,507,619 | 11,159,483 |

| State. | Lead. | | Zinc. | | Total value. |
|---|---|---|---|---|---|
| | Short tons. | Value. | Short tons. | Value. | |
| Arkansas | 42 | $4,620 | 134 | $15,276 | $19,896 |
| Illinois | 1,325 | 145,750 | 3,124 | 356,136 | 507,911 |
| Kansas | 23,271 | 2,559,810 | 56,225 | 6,409,650 | 8,969,460 |
| Kentucky | 92 | 10,120 | 142 | 16,188 | 26,308 |
| Michigan | | | | | 16,808,159 |
| Missouri | 178,412 | 19,625,320 | 16,171 | 1,843,494 | 21,789,119 |
| Oklahoma | 62,856 | 6,914,160 | 209,682 | 23,903,748 | 30,817,908 |
| Wisconsin | 691 | 76,010 | 10,952 | 1,248,528 | 1,324,538 |
| Total, 1921 | 266,689 | 29,335,790 | 296,430 | 33,793,020 | 80,263,299 |
| | 242,050 | 21,784,500 | 175,262 | 17,526,200 | 50,852,157 |

*Silver.*—Nearly all the silver that has been produced in the Central States was recovered incidentally in the production of other metals. The output in 1922 from the copper lodes of Michigan showed an increase of 66,263 ounces, and that from the refining of lead bullion from Missouri increased 142,754 ounces.

The lead-zinc-fluorspar deposits of the Kentucky-Illinois field also carry silver, and the silver recovered from the lead concentrates from Illinois was 6,025 ounces, an increase of 4,680 ounces.

*Copper.*—The mine production of copper in the Central States in 1922 came from Michigan and Missouri. Michigan, which, as in other years, contributed nearly the whole of the output, produced 35,342,337 pounds more than in 1921. The copper produced in Missouri was derived entirely from lead ores. The total mine production of copper from Michigan and Missouri in 1922 was about 152,000,000 pounds less than in 1916.

*Lead.*—The mine production of lead in the Central States in 1922 showed an increase of 10 per cent. Missouri produced 67 per cent of the yield, against 74 per cent in 1921, and the recoverable lead content of galena and lead carbonate concentrates mined in Missouri equaled 38 per cent of the refined primary lead recovered in the United States from domestic ore. Of the total output of lead in Missouri the disseminated-lead district of southeastern Missouri produced 176,596 tons, again exceeding the Coeur d'Alene district of Idaho and retaining first place in the production of lead in the United States. Small shallow lead mines and barytes mines in southeastern Missouri reported the recovery of 172 tons of lead. Southwestern Missouri had an output of 1,644 tons, or 294 tons more than in 1921. The production in Oklahoma increased from 41,552 tons in 1921 to 62,856 tons in 1922.

The production from Kansas mines increased from 18,679 tons in 1921 to 23,271 tons in 1922; Illinois increased from 672 to 1,325 tons, and Wisconsin decreased from 972 to 691 tons. The total production of lead from mines in the southern Illinois-Kentucky region, Arkansas, and the upper Mississippi Valley amounted to less than 1 per cent of the output of the Central States.

*Zinc.*—The figures showing production of zinc in the Central States in 1922 are based on mine returns, with a deduction for separating and smelting losses. The production of zinc in the Central States was about 84 per cent of the total output of primary zinc from domestic ores in the United States, against 88 per cent in 1921.

Oklahoma produced 193,511 tons more zinc than Missouri. For many years, until 1917, Missouri had been the largest producer of zinc in the United States, but the output has decreased from 132,918 tons in 1917 to 16,171 tons in 1922. The production of zinc in Kansas rose from 36,994 tons in 1921 to 56,225 tons in 1922. Arkansas increased in output from 15 to 134 tons; Kentucky decreased from 220 to 142 tons; northern Illinois increased from 2,426 to 3,124 tons. No production of lead or zinc was reported from Iowa mines in 1922.

## PRODUCTION OF LEAD AND ZINC, BY REGIONS.

The productive lead and zinc territory in the Central States naturally falls into seven regions, three of which are not limited to a single State. For statistical purposes the tables showing the production of lead and zinc by States are necessary, but for practical purposes it is desirable to show the production by the natural regions irrespective of State lines.

The seven regions are, in order of size of output, (1) the Joplin region, comprising southwestern Missouri, southeastern Kansas, and northeastern Oklahoma; (2) southeastern Missouri, containing the great deposits of disseminated lead; (3) the upper Mississippi Valley region, including all the lead and zinc mines in southwestern Wisconsin, Iowa, and northwestern Illinois; (4) the fluorspar region in southern Illinois and northern Kentucky; (5) northern Arkansas; (6) central Missouri; (7) the Arbuckle Mountain region, in southern Oklahoma.

The southeastern Missouri region produced 66 per cent of the lead output of the Central States and 38 per cent of the primary lead recovered from domestic ore smelted or refined in the United States in 1922. The Joplin region alone produced 33 per cent of the lead and 95 per cent of the zinc of the Central States in 1922 and was much the largest producer of zinc in the United States, yielding 80 per cent of the total zinc produced from domestic ores, as against 85 per cent in 1921.

The lower zinc content of the zinc concentrates produced at mines in the upper Mississippi Valley region is clearly indicated by the fact that, although these mines yielded nearly 9 per cent of the total output of raw zinc concentrates of all classes, the recoverable zinc content of such concentrates was only 4.7 per cent of the recoverable zinc from mines in the Central States.

The lead content of the galena concentrates shipped from the upper Mississippi Valley region averaged 74.5 per cent, that of the

concentrates from the Joplin region averaged between 80 and 81 per cent, and that of the concentrates from the southeastern Missouri region averaged 66.5 per cent. A very small proportion of the galena shipped from the Joplin region contained more than 83 per cent. A large part of the sphalerite shipped from the Joplin region contained nearly 60 per cent of zinc, and the 31,238 tons shipped from the Waco district in that region averaged 61.8 per cent.

*Mine production of lead and zinc in the Central States in 1922, by regions.*

| Region. | Lead.[a] | | Zinc.[b] | | Total value. |
|---|---|---|---|---|---|
| | Short tons. | Value. | Short tons. | Value. | |
| **Concentrates.** | | | | | |
| Joplin | 111,412 | $8,443,275 | 524,265 | $17,826,304 | $26,269,579 |
| Southeastern Missouri [c] | 271,294 | 14,779,869 | ..... | ..... | 14,779,869 |
| Upper Mississippi Valley [d] | 1,722 | 112,587 | 48,857 | 791,143 | 903,730 |
| Kentucky-southern Illinois | 1,232 | 85,021 | 419 | 8,373 | 93,394 |
| Northern Arkansas | 55 | 4,000 | 425 | 6,870 | 10,870 |
| | 385,715 | 23,424,752 | 573,966 | 18,632,690 | 42,057,442 |
| Total, 1921 | 359,347 | 15,910,279 | 338,477 | 7,485,152 | 23,395,431 |
| **Metal.** | | | | | |
| Joplin | 87,771 | 9,654,810 | 282,078 | 32,156,892 | 41,811,702 |
| Southeastern Missouri [c] | 176,768 | 19,444,480 | ..... | ..... | 19,444,480 |
| Upper Mississippi Valley [d] | 1,259 | 138,490 | 14,076 | 1,604,664 | 1,743,154 |
| Kentucky-southern Illinois | 849 | 93,390 | 142 | 16,188 | 109,578 |
| Northern Arkansas | 42 | 4,620 | 134 | 15,276 | 19,896 |
| | 266,689 | 29,335,790 | 296,430 | 33,793,020 | 63,128,810 |
| Total, 1921 | 242,050 | 21,784,500 | 175,262 | 17,526,200 | 39,310,700 |

[a] Includes both galena and lead carbonate concentrates.
[b] Includes sphalerite, zinc carbonate, and zinc silicate concentrates.
[c] Includes a small production from the central Missouri region.
[d] Includes Iowa, northern Illinois, and Wisconsin.

Mineral Resources for 1914 contains brief reviews of the history of lead and zinc mining in the Central States, the yearly production of each State for the period 1907 to 1914, inclusive, and historical notes and estimates of the total production of lead and zinc in each State before 1907.

## ARKANSAS.

The value of the recoverable lead and zinc from Arkansas mines, which was $1,430,668 in 1917, was only $19,896 in 1922. The decrease in shipments was caused entirely by the low price of zinc carbonate concentrates and lack of demand for them, which permitted only a few sales at the end of 1922.

The production of galena in Arkansas is small compared with that in other regions. The shipments of zinc carbonate and zinc silicate concentrates, 425 tons, were less than 3 per cent of the shipments in 1917.

*Mine production of lead and zinc in Arkansas, 1907–1922.*[a]

| Year. | Ores. | | | | | | Metal content. | | | |
|---|---|---|---|---|---|---|---|---|---|---|
| | Lead concentrates (galena). | | Zinc concentrates. | | | | Lead. | | Zinc. | |
| | | | Sphalerite. | | Silicate and carbonate. | | | | | |
| | Short tons. | Value. | Short tons. | Value. | Short tons. | Value. | Short tons. | Value. | Short tons. | Value. |
| 1907–1915 | 416 | $22,348 | 8,576 | $315,910 | 12,221 | $506,842 | 331 | $29,394 | 8,290 | $1,365,538 |
| 1916 | 339 | 28,097 | 1,670 | 112,726 | 16,609 | 940,224 | 272 | 37,536 | 6,815 | 1,826,420 |
| 1917 | 474 | 47,593 | 916 | 57,824 | 17,053 | 650,585 | 382 | 65,704 | 6,691 | 1,364,964 |
| 1918 | 155 | 13,594 | 310 | 16,450 | 2,156 | 68,333 | 120 | 17,040 | 951 | 173,082 |
| 1919 | 35 | 2,400 | ..... | ..... | 510 | 18,170 | 28 | 2,968 | 189 | 27,594 |
| 1920 | 10 | 755 | ..... | ..... | 917 | 28,925 | 8 | 1,280 | 329 | 53,298 |
| 1921 | 27 | 1,510 | ..... | ..... | 42 | 580 | 21 | 1,890 | 15 | 1,500 |
| 1922 | 55 | 4,000 | ..... | ..... | 425 | 6,870 | 42 | 4,620 | 134 | 15,276 |

[a] In calculating the metal content of the ores from assays allowance has been made for smelting losses of both lead and zinc in 1921 and 1922. In comparing the values of ore and metal it should be borne in mind that the value given for the ore is that actually received by the producer, whereas the value of the lead and zinc is calculated from the average price of all grades.

*Tenor of lead and zinc ore and concentrates produced in Arkansas in 1920–1922.*

| | 1920 | 1921[a] | 1922 |
|---|---|---|---|
| Total crude ore, short tons | 9,800 | ..... | ..... |
| Total concentrates in crude ore: | | | |
| Lead, per cent | 0.11 | ..... | ..... |
| Zinc, do | 9.36 | ..... | ..... |
| Metal content of crude ore: | | | |
| Lead, do | .08 | ..... | ..... |
| Zinc, do | 3.73 | ..... | ..... |
| Average lead content of galena concentrates, do | 80.0 | 77.7 | 78.2 |
| Average zinc content of zinc silicate and carbonate, do | 39.9 | 40.0 | 36.0 |
| Average value per ton: | | | |
| Galena concentrates | $75.50 | $55.93 | $72.73 |
| Zinc silicate and carbonate | $31.54 | $13.81 | $16.16 |

[a] The quantity of ore mined was very small, and none of it was milled, so that no calculations as to tenor are available; ore sold was hand cobbed.

The mines are principally in Boone and Marion counties and the adjoining portions of Searcy and Newton counties, though there are also numerous mines and prospects in Baxter, Izard, Sharp, Lawrence, and other counties to the east, and deposits have been worked in Washington and Sevier counties, on the extreme western border of the State.

The ores are galena, sphalerite, and smithsonite, and the concentrates produced are generally of high grade and free or nearly free from iron or lime. The sphalerite and smithsonite are shown by analysis to contain appreciable quantites of cadmium, especially in a yellow variety of smithsonite known locally as "turkey fat," which shows as much as 0.8 per cent of cadmium.

Few of the lead and zinc mines in Arkansas were operated in 1921 and 1922, and none of those from which concentrates were shipped were operated steadily. The shipments of lead or zinc ore made in 1922 came from six small mines, and the value of the concentrates shipped increased from $2,090 in 1921 to $10,870 in 1922.

The Ozark mine, near Flippin, in Marion County, and the lessees of the American Zinc, Lead & Smelting Co.'s land in Newton County

produced all the zinc concentrates shipped in 1922, and mines on the Brewer land and the Baker & Hanley land, at Ponca, in Newton County, produced nearly all the galena concentrates.

A hand jig plant was operated at the J. E. Nischwitz prospect, near Flippin, Marion County, but no ore was sold.

The Ozark Mining Co. has a 250-foot tunnel and a 150-ton mill equipped with jigs and 10 tables. Considerable development work was done and about 1,000 tons of ore was milled, though little of the concentrate was sold in 1922.

The mines at Rush, which were large producers in 1917, shipped no zinc carbonate in 1922.

In addition to carbonate concentrates in stock at Zinc, Flippin, and Rush Creek at the end of 1922 there were accumulations of carbonate ore at the Bald Hill, Spear, and Big Joe mines and at shipping points for the small prospects on Cow Creek in Marion County.

## ILLINOIS.

By J. P. Dunlop.

### PRODUCTION.

*Mine production of lead and zinc in Illinois in 1922, by districts.*[a]

| District. | Ores. | | | | Metal content.[b] | | | |
|---|---|---|---|---|---|---|---|---|
| | Lead concentrates (galena). | | Zinc concentrates (sphalerite). | | Lead. | | Zinc. | |
| | Short tons. | Value. | Short tons. | Value. | Short tons. | Value. | Short tons. | Value. |
| Northern Illinois | 780 | $50,297 | 9,500 | $189,825 | 568 | $62,480 | 3,124 | $356,136 |
| Southern Illinois | 1,100 | 76,656 | ..... | ..... | 757 | 83,270 | ..... | ..... |
| Total, 1921 | 1,880 | 126,953 | 9,500 | 189,825 | 1,325 | 145,750 | 3,124 | 356,136 |
| | 881 | 48,582 | 7,795 | 97,992 | 672 | 60,480 | 2,426 | 242,600 |

[a] Mineral Resources for 1914 contains a historical review of lead and zinc mining in Illinois.

[b] In calculating the metal content of the ores from assays allowance has been made for smelting losses of both lead and zinc. In comparing the values of ore and metal it should be borne in mind that the value given for the ore is that actually received by the producer, whereas the value of the lead and zinc is calculated from the average price of all grades.

*Tenor of lead and zinc ore and concentrates produced in Illinois, 1920–1922.*

| | 1920 | 1921 | 1922 |
|---|---|---|---|
| NORTHERN ILLINOIS. | | | |
| Total crude ore.....short tons.. | 312,000 | 81,400 | 66,150 |
| Total concentrates in crude ore: | | | |
| Lead.....per cent.. | .35 | .85 | 1.18 |
| Zinc.....do.... | 5.77 | 9.46 | 12.55 |
| Metal content of crude ore: | | | |
| Lead.....do.... | .26 | .66 | .88 |
| Zinc.....do.... | 1.87 | 3.44 | 5.83 |
| Average lead content of galena concentrates.....do.... | 74.8 | 77.8 | 74.2 |
| Average zinc content of sphalerite concentrates.....do.... | 32.4 | 36.4 | 40.6 |
| Average value per ton: | | | |
| Galena concentrates | $81.21 | $53.84 | $64.48 |
| Sphalerite concentrates | $22.03 | $12.57 | $19.98 |
| SOUTHERN ILLINOIS. | | | |
| Average lead content of galena concentrates.....per cent.. | 74.7 | 78.0 | 70.2 |
| Average value per ton of galena concentrates | $95.27 | $60.18 | $69.69 |

*Mine production of silver in southern Illinois, 1907–1922.*

| Year. | Silver. | | Lead concentrates, silver bearing. | | Year. | Silver. | | Lead concentrates, silver bearing. | |
|---|---|---|---|---|---|---|---|---|---|
| | Fine ounces. | Value. | Short tons. | Ounces of silver per ton. | | Fine ounces. | Value. | Short tons. | Ounces of silver per ton. |
| 1907–1915. | 25,220 | $14,371 | 4,199 | 6.00 | 1919..... | 4,140 | $4,973 | 715 | 6.16 |
| 1916..... | 5,684 | 3,740 | 874 | 6.50 | 1920..... | 8,193 | 8,930 | 1,252 | 6.55 |
| 1917..... | 7,186 | 5,921 | 1,239 | 5.80 | 1921..... | 1,345 | 1,345 | 181 | 7.43 |
| 1918..... | 8,171 | 8,171 | 1,228 | 6.65 | 1922..... | 6,025 | 6,025 | 1,100 | 5.48 |

The value of the mine production of silver, lead, and zinc in Illinois in 1922 was $507,911, as compared with $304,425 in 1921.

The lead and zinc deposits of Illinois fall into two distinct regions marked by different mineral associations and structural environment. Those of southern Illinois belong to the Kentucky-Illinois fluorspar district; those of northern Illinois belong to the upper Mississippi Valley region.

## NORTHERN ILLINOIS.

The lead and zinc mines of northern Illinois are all in Jo Daviess County, the extreme northwestern county of the State. The ores are galena, smithsonite, and sphalerite, though the first two are much less common now than formerly, when the deposits worked were mostly shallow and above water level.

Although the lead output of northern Illinois, Wisconsin, and Iowa has been large in the past, and the ores have been smelted near the mines,[3] the output in recent years has been comparatively small, and no ores have been smelted in those States.[4] The galena is practically nonargentiferous, and the zinc ores are not known to contain cadmium. Marcasite is very commonly associated with the ores, generally in such quantity as to necessitate roasting and magnetic separation.

The entire output of northern Illinois is included under the Galena district, which comprises the mines from the vicinity of Fever River to the Wisconsin State line.

A small decrease in production of crude ore and small increases in the production of concentrates are shown in the accompanying tables. The percentages of both lead and zinc concentrates recovered increased, as did also the percentages of metal contents in the crude ore.

The largest quantity of lead and zinc concentrates in northern Illinois was derived from the North Unity mine of the Vinegar Hill Zinc Co. Some prospect work was done by Gus E. Brown on the Barnes land, and a shaft was sunk and a number of miners were prospecting for galena. The North Unity was the only property operated all the year.

[3] Cox, G. H., Lead and zinc deposits of northwestern Illinois: Illinois Geol. Survey Bull. 21, p. 14, 1914.
[4] Pulsifer, H. B., History of lead smelting in Wisconsin: Min. and Eng. World, May 2, 1914, p. 821.

## SOUTHERN ILLINOIS.

The lead and zinc deposits of southern Illinois are found in Pope and Hardin counties in rocks of Mississippian age in the northern extension of the Kentucky-Illinois fluorspar district. The principal product of the mines in recent years has been fluorspar, and the yield of galena is small compared with the output from other districts in the Central States.

The total production of galena concentrates for southern Illinois from 1906 to 1922 has been 10,991 tons, most of which has been shipped from the Fairview and Rosiclare mines. The shipments of zinc ores from the district have been comparatively small and scattered. The only recorded shipments of zinc carbonate, aggregating 103 tons, were made from the Empire mine in 1903 or 1904 and from four companies in 1906.

Formerly large bodies of galena near the surface were worked, but galena is now produced incidentally in the concentration of the fluorspar. For this reason it would be misleading to give the quantity of crude ore. The galena of southern Illinois is notably argentiferous as compared with the rest of the Mississippi Valley ores, and the silver content averaged for the last seven years from 5 to 7.5 ounces to the ton of lead concentrate.

Sphalerite, or zinc blende, occurs much less plentifully than galena. It is recovered as zinc middlings in the concentration of the fluorspar. The difficulty of making a clean separation of the zinc middlings has kept down the production of zinc. None has been sold from southern Illinois in the last 13 years, but there is considerable zinc ore stocked at mines which will be milled when prices for zinc are higher.

The shipments of galena concentrates increased from 181 tons in 1921 to 1,100 tons in 1922, and the silver recovered in treating the concentrates increased from 1,345 to 6,025 ounces.

The Fairview Fluorspar & Lead Co., operating on the Good Hope vein, which was first developed in 1862, was idle until October, 1922. Three shafts were operated at the 300-foot level in 1921. The new experimental 250-ton mill was designed to treat the zinc ore that occurs in the mine workings, of which there is a considerable quantity on the dump.

The Rosiclare Lead & Fluorspar Mining Co. operates on an ore body that is probably continuous with that of the Fairview. The mill, designed to handle 500 tons a day and provided with special facilities for saving the lead and zinc, both by jigs and by tables, was idle most of the year, and only a small quantity of galena was shipped. The Hillside Fluorspar Co. opened a new mine and constructed a concentrating plant near Rosiclare in 1921, which was operated in 1922. The shaft is 350 feet deep and the milling plant has a capacity of 200 tons (8-hour shift). The galena ore, assaying 67 per cent lead and about 4.5 ounces of silver a ton, was shipped to the St. Louis plant of the National Lead Co.

## IOWA.

The lead and zinc deposits of Iowa extend along Mississippi River for nearly 80 miles, in Dubuque, Clayton, and Allamakee counties. No shipments of lead or zinc concentrates from mines in Iowa have been reported since 1918.

## KANSAS.

By J. P. Dunlop.

*Mine production of lead and zinc in Kansas, 1922, by districts.*[a]

| District. | Ores. | | | | Metal content. | | | |
|---|---|---|---|---|---|---|---|---|
| | Lead concentrates (galena). | | Zinc concentrates (sphalerite). | | Lead. | | Zinc. | |
| | Short tons. | Value. | Short tons. | Value. | Short tons. | Value. | Short tons. | Value. |
| Badger-Peacock-Crestline | 305 | $25,599 | 83 | $2,907 | 240 | $26,400 | 41 | $4,674 |
| Waco (in Kansas) | 152 | 9,880 | 10,200 | 337,980 | 122 | 13,420 | 5,679 | 647,406 |
| Blue Mound-Baxter Springs | 28,805 | 2,252,981 | 93,826 | 3,152,888 | 22,780 | 2,505,800 | 50,450 | 5,751,300 |
| Galena | 174 | 11,650 | 110 | 4,255 | 129 | 14,190 | 55 | 6,270 |
| Total, 1921 | 29,436 | 2,300,110 | 104,219 | 3,498,030 | 23,271 | 2,559,810 | 56,225 | 6,409,650 |
| | 22,679 | 1,223,917 | 68,450 | 1,585,051 | 18,679 | 1,681,110 | 36,994 | 3,699,400 |

[a] In calculating the metal content of the ores from assays, allowance has been made for smelting losses of both lead and zinc. In comparing the values of ore and metal it should be borne in mind that the value given for the ore is that actually received by the producer, while the value of the lead and zinc is calculated from the average price for all grades.

*Tenor of lead and zinc ore and concentrates produced in Kansas, 1920–1922.*

| | 1920 | 1921 | 1922 |
|---|---|---|---|
| Total crude ore, short tons | 1,704,700 | 1,132,000 | 2,151,200 |
| Total concentrates in crude ore: | | | |
| Lead, per cent | 1.22 | 2.00 | 1.37 |
| Zinc, do | 6.63 | 6.05 | 4.85 |
| Metal content of crude ore: | | | |
| Lead, do | .98 | 1.63 | 1.10 |
| Zinc, do | 3.98 | 3.63 | 2.90 |
| Average lead content of galena concentrates, do | 80.6 | 81.6 | 80.6 |
| Average zinc content of sphalerite concentrates, do | 60.0 | 60.1 | 59.9 |
| Average value per ton: | | | |
| Galena concentrates | $96.27 | $53.79 | $78.14 |
| Sphalerite concentrates | $45.36 | $23.16 | $33.56 |

The lead and zinc deposits of Kansas, so far as developed, are limited to Cherokee County, in the southeastern part of the State. They form the western extension of the ore deposits of the Joplin region and display the general characteristics shown in that region, except that here typical sheet-ground deposits have not been extensively developed.

It is difficult to ascertain the production for early years or to segregate the Kansas ores from those produced in the Missouri portion of the Joplin region. If to the figures for 1886 to 1903, published by the Kansas Geological Survey,[5] are added those for 1904 to 1922, published by the United States Geological Survey, a total of 1,513,999 tons of zinc concentrates and 249,421 tons of lead concentrates is shown as the approximate production of Kansas for 1886 to 1922. About 50 mines, of which 31 were in the Blue Mound-Baxter area, shipped lead or zinc in 1922.

[5] Haworth, Erasmus, and others, History, geography, geology, and metallurgy of Galena-Joplin lead and zinc: Kansas Univ. Geol. Survey, vol. 8, 1904.

The older mining camps at Lawton and Badger produced much less zinc and lead in 1922 than in 1920, though more than in 1921, and nearly all the production from Kansas came from the Blue Mound-Baxter district, an extension of the Miami field, and the Waco camp, on the Kansas-Missouri State line. The Crestline district had an increased output and will probably produce still more in 1923.

The increase in lead concentrates was due to the larger recoveries of lead from the new mines near Blue Mound, whose mills treated about 90 per cent of all the crude ore mined in Kansas.

The zinc content of the sphalerite from the Waco district was more than 61.5 per cent and that from the Blue Mound-Baxter district about 59.7 per cent.

*Badger-Peacock-Crestline district.*—The production of the Badger-Peacock-Crestline district, including shipments of galena and sphalerite from mines west of Badger, was 305 tons of galena and 83 tons of sphalerite, against 164 tons of galena and 162 tons of sphalerite in 1921. Lessees of the Connor land and Stephens land, including Bentley & Cox, shipped lead and sphalerite. The Pershing mine, on the Chanute Spelter Co.'s lease, was operated by Jackson & Co., who milled ore taken from an upper run. The mine has since been sold to Andrew Bros., who have deepened the shaft and built a larger milling plant. The Kanok Mining Co.'s mill (200 tons), the largest producer at Crestline in 1922, was destroyed by fire in March, but a new plant was built and operations were resumed in August. Shafts have been sunk to the lower run of ore, and a large output is expected in 1923. The Barnsdall Zinc Corporation leased the old Badger-Peacock mine and other adjoining lands, unwatered the ground, and put the mines in condition for operation in 1923. New leases were being drilled near Crestline by the Chanute Spelter Co. and Underwriters Land Co., and a 250-ton mill was built by the Interstate Lead & Zinc Co.

*Lawton-Waco district.*—The output of the Lawton-Waco district came from the mines near Waco, as the one producing property at Lawton—that of the Eastern Lead & Zinc Co.—was idle. The total output of the Waco district, lying partly in Missouri and partly in Kansas, was 31,238 tons of sphalerite and 312 tons of galena, against 33,803 tons of sphalerite and 297 tons of galena in 1921. The production of the Kansas portion of the district was 10,200 tons of sphalerite and 152 tons of galena, as compared with 15,526 tons of sphalerite and 152 tons of galena in 1921. The principal producing properties in the Kansas part of the Waco district were the Butte Kansas No. 2, which was operated part of the year, and the Barnsdall Zinc Mining Co. No. 3, which was the largest producer. Considerable drilling was done on the Butte Kansas No. 2, which showed bodies of ore at levels between 275 and 330 feet. Butte Kansas No. 1 was reopened late in 1922, and shaft No. 5 was sunk to the ore body now being mined at 195 to 230 feet.

*Galena district.*—The production of lead concentrates in the Galena district was 174 tons, as compared with 17 tons in 1921. There were small shipments of sphalerite concentrates derived from old dumps cleaned at chat mills. The Eagle Picher Lead Co. did some drilling but ceased operations in the fall and relinquished its leases. Most

of the sphalerite was produced at the R. C. Shellac custom mill, and the remainder came from the Rock Hill Mining Co.'s lease on the Weymann land. All the output was derived from clean-ups or from shallow mining, as the mines in this field are flooded and no pumping was done in 1922.

*Blue Mound-Baxter Springs district.*—Notwithstanding adverse conditions early in 1922 there was considerable activity in that part of Cherokee County south and west of Baxter Springs and north of the Oklahoma State line. Interests represented by Rakowsky & Naething, called the Kansas Exploration Co., continued the extensive drilling campaign covering a large section of Cherokee County, frequently operating 25 to 30 drill rigs. The Eagle Picher Lead Co., Federal Mining & Smelting Co., Black Eagle Mining Co., Chubb Mining Co., Lucky Jew Mining Co., and Commerce Mining & Royalty Co. explored with drills a large part of the territory northwest of Picher, including the old United States Smelting tract and the Kanoma, Kansouri, Chubb, D'Armond, Rebecca, and Silverplume leases. New shafts were sunk, and several new mills were erected.

Most of the output in 1922, as in 1921, came from mines north and northwest of the Picher area and close to the State line, and mines north of Hockerville and east and north of Blue Mound produced less than in 1921.

The shipments of concentrates, which in 1921 amounted to 22,346 tons of galena and 52,762 tons of sphalerite, were 28,805 tons of galena and 93,826 tons of sphalerite. The average lead content of the galena sold was 80.6 per cent, and the zinc content of the sphalerite concentrates sold was 59.7 per cent. The crude ore ("dirt") milled yielded 6.32 per cent in concentrates, and at some mines the recovery was more than 10 per cent. Of the total shipments 64 per cent came from mines west and northwest of Blue Mound, which shipped 56 per cent in 1921. About 80 per cent of the lead shipped from the district came from mines west and northwest of Blue Mound. The sales of zinc concentrates were more than the production, and the only large stock of sphalerite in bins at mines near Blue Mound was that at the Webber mine.

The producing properties in the area west and northwest of Blue Mound were the State Line Zinc Co. (Blue Diamond), Vinegar Hill (Barr), Webber, West Side, Early Bird, Southern, Crescent, Beaumont (old Tampa), Bethlehem, Lucky Jew, Black Eagle No. 2, Silver Fox, Bendelari, Big Elk, Lawyers, Redskin, King Brand, and Muncie. The producing properties north of Hockerville and Zincville and east and north of Blue Mound were the Hartley, Brewster, Ebenstein (Chanute Spelter Co.), Kansas Line, Monarch, Commonwealth No. 2, Euterpe, Lucky O. K., English O., Empire, Homestake, and Queen Esther. The Webber mill operated on very rich ore and produced more lead than any mine in the Joplin region. The production of sphalerite was also large.

New concentrating plants were erected by the English O. Mining Co. (150 tons), Weneeda Mining Co. (200 tons), Chanute Spelter Co., Ebenstein (300 tons), Chubb Mining Co. (300 tons), and Bendelari Mining Co. (350 tons).

The Barr, West Side, Webber, Southern, Lucky O. K., King Brand, Hartley, and Early Bird mines each shipped more than 1,000 tons

of galena in 1922. The mines that shipped more than 3,000 tons of sphalerite in 1922 were the Barr, West Side, Webber, Southern, Lucky O. K., Lucky Jew, Blue Diamond, Queen Esther, Empire, Euterpe, Hartley, Brewster, Muncie, Lawyers, Bendelari, Early Bird, and Silver Fox. The Southern mine was taken over by F. W. Evans, the Tampa by the Beaumont Mining Co., the Naylor by the Black Eagle Mining Co., and the Crescent by A. F. Carmean.

## KENTUCKY.

By J. P. Dunlop.

Lead and zinc deposits are found in both central and western Kentucky. None of the mines in the central districts reported any lead or zinc concentrates shipped in 1922. The deposits in the fluorspar region of western Kentucky are chiefly in Crittenden, Caldwell, and Livingston counties and form a continuation of those in the southern Illinois lead and zinc region.

Considerable quantities of galena ores have been produced in former years, but at present lead is obtained solely as a by-product in the recovery and concentration of fluorspar, which is the principal economic mineral. The galena recovered is argentiferous, the silver content varying from a very small quantity to more than 3 ounces a ton, but no recovery of this silver content has been reported by the smelters during the last 11 years.

*Mine production of lead and zinc in Kentucky, 1907–1922.*

| Year. | Ores. | | | | | | Metal content. | | | |
|---|---|---|---|---|---|---|---|---|---|---|
| | Lead concentrates (galena). | | Zinc concentrates. | | | | Lead. | | Zinc. | |
| | | | Sphalerite. | | Zinc carbonate. | | | | | |
| | Short tons. | Value. | Short tons. | Value. | Short tons. | Value. | Short tons. | Value. | Short tons. | Value. |
| 1907–1915 | 799 | $31,602 | 723 | $31,717 | 4,909 | $160,669 | 480 | $44,390 | 2,040 | $342,886 |
| 1916 | 227 | 16,868 | 125 | 6,407 | 2,923 | 126,875 | 153 | 21,114 | 1,096 | 293,728 |
| 1917 | 184 | 15,415 | ..... | ..... | 2,299 | 78,368 | 123 | 21,156 | 751 | 153,204 |
| 1918 | 255 | 21,066 | ..... | ..... | 927 | 30,390 | 185 | 26,270 | 315 | 57,330 |
| 1919 | 120 | 7,250 | ..... | ..... | 120 | 3,600 | 86 | 9,116 | 36 | 5,256 |
| 1920 | 172 | 12,295 | ..... | ..... | 25 | 750 | 122 | 19,520 | 9 | 1,458 |
| 1921 | 100 | 3,693 | ..... | ..... | 621 | 19,800 | 69 | 6,210 | 220 | 22,000 |
| 1922 | 132 | 8,365 | ..... | ..... | 419 | 8,373 | 92 | 10,120 | 142 | 16,188 |

The average lead content of galena concentrates in 1921 and 1922 was 71 per cent. The total value of the lead and zinc concentrates shipped from Kentucky mines was $16,738, against $23,493 in 1921.

The principal sellers of galena concentrates were the Kentucky Fluorspar Co. and the Keystone Fluorspar & Lead Co. The Zinc & Spar Co. operated the Hudson mine, near Salem, in Livingston County, part of the year. The zinc carbonate ore was taken from workings about 85 feet in depth and treated in log washers before shipment.

## MICHIGAN.

By F. Begeman.

### PRODUCTION.

The smelter output of refined copper in Michigan in 1922 was 122,545,126 pounds, as compared with 100,918,001 pounds in 1921. The difference between the mine and the smelter production is due to the fact that the quantity of concentrates or "mineral" produced is not the same as the quantity smelted. A company may produce either more or less "mineral" than it smelts during the year.

*Mine production of silver and copper in Michigan in 1921 and 1922.*[a]

| Year. | Silver (fine ounces). | Copper. | | | Concentrate ("mineral"). | | Ore ("rock") (short tons). |
|---|---|---|---|---|---|---|---|
| | | Pounds. | Yield. | | Pounds. | Yield (per cent). | |
| | | | Pounds per ton of ore ("rock"). | Percentage. | | | |
| 1921 | 310,727 | [b] 86,370,028 | 23.9 | 1.19 | [c]148,024,931 | 58.4 | [d] 3,610,648 |
| 1922 | [e] 376,990 | [b] 121,712,365 | 24.6 | 1.23 | [c] 193,984,975 | 62.7 | [d] 4,952,264 |
| Increase | 66,263 | 35,342,337 | .7 | ..... | 45,960,044 | ..... | 1,341,616 |

[a] The figures are based on the actual recovery of copper from "mineral" smelted and the estimated recovery from "mineral" that was not smelted during the year.
[b] Includes copper from sands.
[c] Includes "mineral" from sands.
[d] Includes sands.
[e] Derived from the electrolytic treatment of 31,062,869 pounds of copper.

*Value of silver and copper produced in Michigan mines in 1921 and 1922.*

| Year. | Silver. | Copper | | Total. |
|---|---|---|---|---|
| | | Total. | Per ton of ore ("rock"). | |
| 1921 | $310,727 | $11,141,734 | $3.09 | $11,452,461 |
| 1922 | 376,990 | 16,431,169 | 3.32 | 16,808,159 |
| Increase | 66,263 | 5,289,435 | .23 | 5,355,698 |

### HOUGHTON COUNTY.

Houghton County occupies the central portion of the copper belt and contains 7 of the 10 mines that produced copper in 1922.

The Calumet & Hecla Mining Co. has been one of the most successful copper-mining companies in the world. Up to and including March 15, 1923, it has distributed $153,950,000 in dividends. The company's ground contains three copper-bearing lodes—the Calumet & Hecla conglomerate, the Osceola amygdaloid, and the "Kearsarge" amygdaloid—but only the first was productive in 1922.

The company's annual report shows the details of operation for 1922 as follows: In all, 618,800 short tons of "rock" was treated,

yielding 29,130,500 pounds of copper, or an average of 47.08 pounds per ton of "rock," compared with 37.75 pounds for 1921. The total cost per pound of copper was 15.75 cents, including 6 cents for depreciation and depletion. The recovery of copper from old sands added to the recovery from "rock" made a total production of 40,493,000 pounds.

The reclamation plant for treating old tailings treated 1,378,250 tons having an average copper content of 8.24 pounds to the ton. A total of 11,362,500 pounds of copper was recovered, at an average cost, exclusive of smelting and selling, of 6.28 cents.

*Summary of operations of regrinding plant, Calumet & Hecla Mining Co., 1922.*

| | | From mine. | From old sands. |
|---|---|---|---|
| Ore treated | short tons | 340,340 | 489,150 |
| Assay of headings | per cent | 0.765 | 0.647 |
| Assay of tailings | do | .503 | .434 |
| Refined copper | pounds | 1,756,000 | 2,089,000 |
| Refined copper per ton treated | do | 5.16 | 4.17 |
| Cost per pound, exclusive of smelting and selling | cents | 5.22 | 8.62 |

*Summary of operations of leaching plant, Calumet & Hecla Mining Co., 1922.*

| | | |
|---|---|---|
| Ore treated | short tons | 1,353,654 |
| Assay of headings | per cent | 0.488 |
| Assay of tailings | do | .108 |
| Refined copper | pounds | 10,455,000 |
| Refined copper per ton treated | do | 7.72 |
| Cost per pound of copper, exclusive of smelting and selling | cents | 3.86 |

Smelter operations were continuous throughout the year but on a very small scale until April. No construction work of any consequence was done. There have been some changes in operation, experimental as yet, tending toward reduction of the quantity of copper produced in the cupola and requiring electrolytic treatment. As a consequence the electrolytic plant was closed in December and may not be reopened until there is an increase in silver-bearing copper from some of the amygdaloid lode mines now closed.

By April 1 conditions in the copper industry seemed to warrant the resumption of partial production from the conglomerate lode of this mine and from the sands at Lake Linden.

No copper was produced by the Osceola Co. in 1922. Since 1878 this company has distributed dividends amounting to $18,044,825.

The Wolverine Co. was among the producers of copper for 1922. The published report of the company for the fiscal year ending June 30, 1923, is not yet available, and it is therefore not possible to give a detailed statement of its operations. During the fiscal year ending June 30, 1922, the company stamped 290,419 tons of "rock," which produced 6,829,590 pounds of "mineral," yielding 3,924,270 pounds of refined copper, or 13.512 pounds of refined copper to the ton. The total cost per pound of refined copper was 19.093 cents, including depreciation and depletion. Since its organization to June 30, 1922, the company has produced 177,096,101 pounds of copper.

At the Quincy 674,499 tons of "rock" was mined in 1922, which yielded 24,806,828 pounds of "mineral" and 15,402,726 pounds of

copper, an average of 22.83 pounds to the ton. The total disbursements in dividends since 1862 amount to $27,002,500.

At Isle Royale "rock" amounting to 246,641 tons was treated, yielding an average of 26.92 pounds of copper to the ton. The average cost per pound of copper was 14.19 cents, including 3.62 cents for depreciation and depletion. Since its organization the company has disbursed $2,250,000 in dividends.

A total of 165,804 tons of "rock" from the Baltic mine was stamped, producing 32.14 pounds of refined copper to the ton, at a cost of 16.76 cents a pound. A total of 130,913 tons of "rock" from the Trimountain was stamped, yielding an average of 31.44 pounds to the ton, at an average cost of 16.46 cents a pound. Since its organization the company has disbursed $3,250,000 in dividends.

The Champion Copper Co., controlled jointly by the Copper Range Co. and the St. Mary's Mineral Land Co., stamped 503,593 tons of "rock," which produced 38.964 pounds of copper to the ton, at a cost of 19.86 cents a pound. Since its organization this company has disbursed $26,450,260.96 in dividends.

The Arcadian Consolidated Mining Co. did not produce any copper during 1922, its operations being confined to development work.

The mines of the Centennial Copper Mining Co., Franklin Mining Co., Superior Copper Co., La Salle Copper Co., Winona Copper Co., and Hancock Consolidated Mining Co. were idle during the year.

### KEWEENAW COUNTY.

Keweenaw County occupies the northern portion of the copper belt.

At the Ahmeek mine 439,769 tons of "rock" was stamped in 1922 and yielded 33.85 pounds of refined copper to the ton, at a total cost per pound of 12.91 cents, including 4.47 cents for depreciation and depletion. The total dividends disbursed by the company amount to $12,750,000.

Satisfactory development work was continued by the Seneca Copper Corporation during 1922. From this work 8,617.9 tons of "rock" was stamped, producing 272,182 pounds of refined copper, or 31.583 pounds to the ton.

At the Mohawk mine 512,393 tons of "rock" was stamped and yielded 11,209,396 pounds of copper, or an average of 21.88 pounds to the ton, at a total cost of 16.063 cents a pound. The total dividends to December, 1922, amounted to $9,975,000.

The Allouez Mining Co. produced no copper in 1922, and no work of any kind was done at the Allouez mine during the year. The total dividends of this company to April, 1919, amounted to $2,850,000.

### ONTONAGON COUNTY.

No active mining operations were carried on at the properties in Ontonagon County in 1922.

## MISSOURI.

By J. P. Dunlop.

### PRODUCTION.

The value of the mine production of recoverable silver, copper, lead, and zinc in Missouri in 1922 was $21,789,119, compared with $17,379,801 in 1921. The value of copper increased $89,900, that of lead $3,417,670, that of silver $142,754, and that of zinc $758,994. The recoverable lead content of Missouri lead concentrates sold in 1922 was equal to 38 per cent of the smelter production of primary lead in the United States derived from domestic ores, against 45 per cent in 1921, and the recoverable zinc content from Missouri zinc concentrates sold in 1922 was 4.6 per cent of the primary zinc produced by smelters from domestic ores in 1922, as against 22.7 per cent in 1917. The approximate number of mines and prospects in Missouri that shipped lead or zinc concentrates in 1922 was 80.

*Mine production of copper and silver in Missouri, 1910–1922.*

| Year. | Copper. | | Silver. | | Lead concentrates, silver bearing (short tons). |
|---|---|---|---|---|---|
| | Pounds. | Value. | Fine ounces. | Value. | |
| 1910–1918 | 3,527,293 | $667,666 | 510,920 | $333,582 | 495,823 |
| 1919 | 1,617,200 | 300,799 | [a] 90,401 | 101,249 | 81,000 |
| 1920 | 1,512,539 | 278,307 | [b] 111,128 | 121,130 | 90,000 |
| 1921 | 137,591 | 17,749 | 69,902 | 69,902 | 44,000 |
| 1922 | 797,400 | 107,649 | 212,656 | 212,656 | 138,000 |

[a] Includes 29,480 ounces of silver from cobalt-nickel-copper ore.
[b] Includes 28,664 ounces of silver from cobalt-nickel-copper ore.

The quantities given for silver in the foregoing table are those of recovered silver. The silver content of the lead ores is so small that it is disregarded in the assay and sale of the concentrates. For this reason the smelter reports must be relied on for the silver production. As may be seen by inspection of the table, the quantity of silver produced in any year bears no direct ratio to the quantity of lead concentrates smelted during that year, for the reason that the silver content is so small in quantity that the silver bullion is stored and refined in batches. In a series of years the concentrates average about 1 ounce of silver to the ton.

The North American mine, now owned by the Missouri Cobalt Co., produced no silver, copper, nickel, or cobalt in 1922. The copper was derived from matte recovered in smelting lead ore mined in St. Francois County, in southeastern Missouri.

The value of the recoverable metallic content of the lead and zinc concentrates produced in Missouri in 1922 was $21,468,814, an increase of $4,176,664 over that of 1921. The production of lead concentrates (of which all but 173 tons was galena) was 273,554 short tons, as compared with 282,122 tons in 1921. Of the output in 1922, 271,294 tons was derived from southeastern and central Missouri, a decrease of 9,064 tons. The average metal content of the lead concentrates from these districts was 66.5 per cent, as com-

pared with 65 per cent in 1921, and the value per ton in 1922 was $54.48 as compared with $41.87 in 1921. The quantity of recoverable lead in southeastern and central Missouri concentrates in 1922 amounted to 176,768 tons, a decrease of 1,967 tons.

Shipments of galena concentrates from southwestern Missouri were 2,087 tons, compared with 1,730 tons in 1921. The lead carbonate concentrates amounted to 173 tons, an increase of 139 tons. The quantity of recoverable lead from southwestern Missouri, or the Joplin region, was 1,644 tons, an increase of 294 tons. The average metal content of the galena concentrates from southwestern Missouri was 75.7 per cent, and the average price per ton was $69.44, or $19.29 more than in 1921.

The quantity of zinc blende concentrates sold from Missouri mines was 27,844 tons, an increase of 8,354 tons compared with 1921. All the blende concentrate was produced in southwestern Missouri. The average price received was $31.91 a ton, and the average recoverable zinc content reported by the sellers was 60.3 per cent, compared with $25.18 and 61.7 per cent in 1921.

The zinc carbonate and silicate concentrates sold amounted to 3,008 tons, or 2,948 tons more than in 1921. The output in 1922 came entirely from southwestern Missouri. The average metal content of the zinc carbonate and silicate concentrates was 39.2 per cent, and the average price per ton was $21.25, compared with $10.57 in 1921.

The value of lead concentrates from southeastern and central Missouri (which produced about 99 per cent of the lead concentrates) was $14,779,869, or $3,042,469 more than in 1921. The total value of the lead and zinc concentrates from southwestern Missouri was $1,107,090, compared with $579,245 in 1921.

The total quantity of crude ore or "dirt" mined and treated in Missouri in 1922 was 5,879,700 short tons. As the total amount received for all classes of lead and zinc concentrates sold in 1922 was $15,886,959, the average value per ton of crude ore or "dirt" mined and treated was $2.70.

In the following tables showing the tenor of crude ore ("dirt") and concentrates from Missouri it has been considered advisable to segregate the ores of different nature. The disseminated lead ore of southeastern Missouri differs radically from the lead and zinc ores of the so-called "soft ground" deposits of southwestern Missouri. Each class of ore has its peculiar problems of mining and ore dressing. The data are given for the ores mined in the Joplin region, but as the recoveries from "sheet ground" were very small in 1920 and there were none in 1922, it was not possible to differentiate between the "soft ground" and "sheet ground" recoveries. In general, the tables reflect very closely the conditions of the industry.

The much lower percentage of concentrates recovered from crude ore treated in 1922 was due mainly to the large quantity of low-grade ore mined from the open cut at the Oronogo Circle mine, at Oronogo. This low-grade ore was shot down several years ago and contains considerable clay and shale. It is expected that all this material will be removed by July, 1923, and that the normal recovery of concentrates from crude ore will be reached.

*Mine production of lead and zinc in Missouri in 1922, by districts.*

| District. | Lead concentrates. | | | | Zinc concentrates. | | | |
|---|---|---|---|---|---|---|---|---|
| | Galena. | | Carbonate. | | Sphalerite. | | Silicate and carbonate. | |
| | Short tons. | Value. | Short tons. | Value. | Short tons. | Value. | Short tons. | Value. |
| Ash Grove | 18 | $972 | | | | | | |
| Carl Junction and Carthage | 10 | 710 | | | 91 | $2,660 | | |
| Duenweg | 71 | 4,549 | 72 | $3,845 | 280 | 8,501 | 929 | $19,990 |
| Granby | 257 | 17,778 | | | 222 | 8,119 | 1,836 | 39,112 |
| Joplin | 266 | 19,308 | 91 | 5,505 | 161 | 5,559 | 119 | 2,310 |
| Oronogo | 672 | 46,481 | | | 5,263 | 132,362 | 4 | 105 |
| Spring City-Spurgeon | 32 | 1,911 | 10 | 400 | | | | |
| Stark City and Christian County | 8 | 585 | | | 80 | 2,800 | 120 | 2,400 |
| Webb City-Carterville-Prosperity | 593 | 42,114 | | | 607 | 15,870 | | |
| Wentworth | | | | | 102 | 2,880 | | |
| Waco (in Missouri) | 160 | 10,521 | | | 21,038 | 709,743 | | |
| | 2,087 | 144,929 | 173 | 9,750 | 27,844 | 888,494 | 3,008 | 63,917 |
| Southeastern Missouri | 271,294 | 14,779,869 | | | | | | |
| | 273,381 | 14,924,798 | 173 | 9,750 | 27,844 | 888,494 | 3,008 | 63,917 |
| Total, 1921 | 282,088 | 11,824,166 | 34 | 1,114 | 19,490 | 490,731 | 60 | 634 |

| District. | Metal content.[a] | | | |
|---|---|---|---|---|
| | Lead. | | Zinc. | |
| | Short tons. | Value. | Short tons. | Value. |
| Ash Grove | 14 | $1,540 | | |
| Carl Junction and Carthage | 8 | 880 | 47 | $5,358 |
| Duenweg | 88 | 9,680 | 484 | 55,176 |
| Granby | 196 | 21,560 | 739 | 84,246 |
| Joplin | 256 | 28,160 | 123 | 14,022 |
| Oronogo | 495 | 54,450 | 2,653 | 302,442 |
| Spring City-Spurgeon | 29 | 3,190 | | |
| Stark City and Christian County | 6 | 660 | 86 | 9,804 |
| Webb City-Carterville-Prosperity | 437 | 48,070 | 286 | 32,604 |
| Wentworth | | | 53 | 6,042 |
| Waco (in Missouri) | 115 | 12,650 | 11,700 | 1,333,800 |
| | 1,644 | 180,840 | 16,171 | 1,843,494 |
| Southeastern Missouri | 176,768 | 19,444,480 | | |
| | 178,412 | 19,625,320 | 16,171 | 1,843,494 |
| Total, 1921 | 180,085 | 16,207,650 | 10,845 | 1,084,500 |

[a] In calculating the metal content of the ores from assays allowance has been made for smelting losses of both lead and zinc. In comparing the values of ore and metal it should be borne in mind that the value given for the ore is that actually received by the producer, whereas the value of the lead and zinc is calculated from the average price for all grades.

*Tenor of crude lead and zinc ore and concentrates produced in southwestern Missouri in 1920–1922.*

| | 1920 a | 1921 a | 1922 |
|---|---|---|---|
| SOFT GROUND.b | | | |
| Total crude ore.....short tons.. | 1,304,400 | 243,300 | 727,300 |
| Total concentrates in crude ore: | | | |
| Lead.....per cent.. | 0.40 | 0.73 | 0.31 |
| Zinc.....do.... | 3.75 | 8.04 | 4.24 |
| Metal content of crude ore: | | | |
| Lead.....do.... | .31 | .57 | .23 |
| Zinc.....do.... | 2.09 | 4.95 | 2.47 |
| Average lead content of galena concentrates.....do.... | 77.7 | 78.4 | 75.7 |
| Average lead content of lead carbonate concentrates.....do.... | 55.0 | 58.8 | 56.1 |
| Average zinc content of sphalerite concentrates.....do.... | 59.5 | 61.7 | 60.3 |
| Average zinc content of silicates and carbonates.....do.... | 39.8 | 38.3 | 39.2 |
| Average value per ton: | | | |
| Galena concentrates..... | $97.84 | $50.15 | $69.44 |
| Lead carbonate concentrates..... | 51.70 | 32.76 | 56.36 |
| Sphalerite concentrates..... | 45.79 | 25.18 | 31.91 |
| Zinc silicates and carbonates..... | 35.50 | 10.57 | 21.25 |

a Includes all ore mined and milled.
b Quantity of ore from "sheet ground" very small; it is included with ore from "soft ground"; no sheet ground mined in 1922.

*Tenor of crude lead ore and concentrates in southeastern Missouri disseminated lead district in 1920–1922.*

| | 1920 | 1921 | 1922 |
|---|---|---|---|
| Total crude lead ore.....short tons.. | 4,803,630 | 5,058,800 | 5,152,400 |
| Galena concentrates in crude ore.....per cent.. | 5.04 | 5.54 | 5.26 |
| Lead content of crude ore.....do.... | 3.35 | 3.60 | 3.50 |
| Average lead content of galena concentrates.....do.... | 66.6 | 65.0 | 66.5 |
| Average value per ton of galena concentrates..... | $81.72 | $41.87 | $54.48 |

In Mineral Resources for 1914, Part I, pages 72–77 and 97–100, was given a brief history of lead and zinc mining in the southeastern Missouri and Joplin regions, together with data relating to the total lead and zinc production, the mining and milling practice, the character of the ore and concentrates, and the methods of selling them.

## SOUTHWESTERN MISSOURI.

### AREA AND PRODUCTION.

The southwestern Missouri lead and zinc areas include the largest part of the Joplin region, the remainder lying in southeastern Kansas and northeastern Oklahoma.

*Lead and zinc concentrates produced in the Missouri part of the Joplin region, 1907–1922*

| | Short tons. | Value. | Average price. |
|---|---|---|---|
| Lead concentrates..... | 440,755 | $27,915,800 | $63.3 |
| Sphalerite concentrates..... | 2,743,456 | 140,219,983 | 51.1 |
| Zinc carbonate and silicate concentrates..... | 291,281 | 9,038,541 | 31.0 |
| | 3,475,492 | 177,174,324 | ..... |

## PRICES.

The following quoted base prices apply not only to southwestern Missouri, but also to all the mines in Oklahoma and Kansas that are in the Joplin region. The average quoted base prices for 60 per cent sphalerite were highest during November, 1922. The prices were $27 to $28 a ton in the first week in January, declined to $25 and $26 the later part of January, and ranged from $24 to $27 in February. The March prices were from $25 to $28, but the April prices increased to $28 and $31, and the May prices were $27 to $32. Prices increased again in June and July, averaging $32 to $37, and remained at about $37 during August. During the later part of September they advanced to $40 to $43. In October they advanced to an average of $42 to $45, in November they reached the highest quoted prices of $45 to $47, and in December a slump made the range from $39 to $40.

Base prices for calamine or zinc silicate ores were not quoted during the early part of 1922, for very little ore was mined. There was naturally a very small demand for carbonate and silicate containing 40 per cent zinc when quotations for 60 per cent sphalerite were $25 to $30 a ton. The demand for zinc silicate ores started about the middle of 1922, and prices offered were about $18 to $20 a ton. An increased output from Granby and Duenweg and a greater demand increased the price to about $24 to $25, and some ore was sold during the later part of 1922 for $26 a ton. Prices quoted were irregular, and for much of the ore the price paid was less than $21.

The quoted price for galena carrying 80 per cent of lead showed wide variations. In January it was $60 to $62 a ton; in December $93. Prices for galena were steady at $60 a ton during January and February, advanced to $65 a ton at the end of March, and advanced again to $69 and $70 the middle of April. In May the price was $70 and in June $78. Early in July it slumped to $75, but at the end of July it had advanced again to $78.50. In August prices were $80 and $81, in September $81 to $85, in October $87.50, in November $91 to $93, and during December remained at the highest price of the year, $93.

*Average prices per ton paid for sphalerite and zinc and lead concentrates in southwestern Missouri, 1915–1922.*

| | 1915 | 1916 | 1917 | 1918 | 1919 | 1920 | 1921 | 1922 |
|---|---|---|---|---|---|---|---|---|
| Sphalerite | $76.25 | $82.60 | $71.04 | $51.27 | $40.67 | $45.79 | $25.18 | $31.91 |
| Zinc silicate or carbonate concentrates | 45.00 | 50.21 | 40.50 | 32.27 | 27.30 | 35.50 | 10.57 | 21.25 |
| Galena concentrates | 52.52 | 84.29 | 101.90 | 89.92 | 66.82 | 97.84 | 50.15 | 69.44 |

These prices are not averages of base-price quotations but averages calculated from the quantity sold and the amounts received as reported to the United States Geological Survey by the sellers.

## GENERAL CONDITIONS.

Though prices for both lead and zinc concentrates were much below normal during most of 1922, and there was considerable increase in the total mine output from the Missouri part of the Joplin

region, there was no development or mining of "sheet ground," and few properties are now equipped with plants. The Missouri portion of the Waco district produced more than 75 per cent of the entire output of sphalerite shipped from southwestern Missouri in 1922, and most of the remainder was shipped from the Oronogo camp. The mines at Waco that contributed the 21,038 tons of sphalerite and 160 tons of galena were those of the Barnsdall Zinc Mining Co., Allegheny Western Mining Co., American Zinc, Lead & Smelting Co., and Tulsa-Pittsburg Mining Co. No concentrates were sold from any mines in the Thoms Station, Sarcoxie-Reeds, Aurora, Spring City, Alba, Neck City, Cave Springs, Belville, and Springfield districts.

There was considerably more prospecting in 1922 than in 1921, especially during the fall, when prices for zinc and lead increased greatly. A demand for zinc carbonate and silicate at fair prices caused the reopening of many old mines and prospecting for new ones in the Granby, Duenweg, Spurgeon, Racine, and Joplin districts, and about 3,000 tons of zinc silicate was shipped, with the prospect of a much increased output in 1923. The higher prices paid for galena and sphalerite resulted in a number of drills being operated in the older camps and an extensive drilling campaign in the area lying between Oronogo, Alba, and Neck City and the productive mines at Waco. Most of this prospecting and development work occurred too late in 1922 to add to the shipments of the year.

The production in the Carthage, Wentworth, Ash Grove, Stark City, Duenweg, Webb City-Carterville, and Spurgeon districts was scattered and small. The only active property at Carl Junction was that of the Indiana Mining Co., which drilled 12 holes and made many improvements at the plant.

The Oronogo Circle mine was operated steadily and milled the largest quantity of ore in Missouri, and a much larger recovery of concentrates is expected in 1923, for the low-grade ore in the open pit will be disposed of. No large plants near Joplin were operated steadily, but a number of small operators shipped 266 tons of galena, 91 tons of lead carbonate, 161 tons of sphalerite, and 119 tons of zinc silicate. Most of the output came from leases of the Connor Investment Co., Mattes land (old Bullfrog), F. F. Creller, J. W. McCulloch, Henry Weymann, and American Zinc, Lead & Smelting Co.

The Webb City-Carterville-Prosperity district had a small output compared with that of former years. The shipments were 593 tons of galena and 607 tons of sphalerite. The largest production of both lead and zinc was made by lessees on the Connor land. Other properties that yielded shipments of lead or zinc were those of the American Zinc, Lead & Smelting Co., Center Creek Mining Co., Eleventh Hour Mining Co., and old Troop 40 acres. Most of the shipments from the district consisted of ores from scrapping and clean-ups. At the end of 1922 few companies were mining ore in southwestern Missouri, and the only large plants in operation were the Barnsdall, Allegheny Western, American Zinc, Lead & Smelting Co., Freehold Oil & Gas Co., and Tulsa Pittsburg, at Waco; the Connecticut Zinc Co., at Oronogo; the Clear Preacher, at Duenweg; numerous lessees on the American Zinc, Lead & Smelting Co.'s land

at Granby; the Boyd-Wilson, at Wentworth; and the Bain & Page, in Christian County, where a new 75-ton mill was finished to take the place of the hand jigs that cleaned the concentrate sold in 1922. Owing to the high prices paid for galena at the end of 1922, numerous small mines were being opened up in many districts, but the aggregate production from such sources will not be more than 1,000 or 2,000 tons a year.

## CENTRAL AND SOUTHEASTERN MISSOURI.

A brief description of the ore deposits in central and southeastern Missouri is given in the separate chapter entitled "Silver, copper, lead, and zinc in the Central States in 1915," which may be obtained upon application to the Director, United States Geological Survey, Washington, D. C.

Copper, nickel, and cobalt occur in the ore, in considerable quantity in the vicinity of Fredericktown and in small quantity irregularly in nearly all deep mines. It is only near Fredericktown that the copper, nickel, and cobalt content of the ore has been the object of mining, yet a concentrate of these metals has been recovered as a table middling at several plants in other parts of the district.

In the disseminated-ore district the production after 1869 increased rapidly and is estimated by Buckley to have amounted to 1,202,607 tons of lead concentrates, valued at $59,869,354, for the period between 1869 and 1906, inclusive. The mine production of southeastern and central Missouri has been reported to the United States Geological Survey since 1907.

*Mine production of lead and zinc concentrates in southeastern and central Missouri, 1907–1922.*

| Year. | Lead concentrates (galena). | | Zinc concentrates. | | | |
|---|---|---|---|---|---|---|
| | | | Sphalerite. | | Carbonate and silicate. | |
| | Short tons. | Value. | Short tons. | Value. | Short tons. | Value. |
| 1907–1915 | 1,945,996 | $85,207,971 | 452 | $13,108 | 8,435 | $168,929 |
| 1916 | 307,025 | 20,720,737 | 365 | 14,400 | 1,030 | 42,129 |
| 1917 | 306,473 | 30,070,995 | 186 | 16,344 | 293 | 7,145 |
| 1918 | 271,506 | 20,507,064 | 13 | 285 | 235 | 6,845 |
| 1919 | 229,687 | 11,590,977 | ..... | ..... | 231 | 6,576 |
| 1920 | 242,248 | 19,799,389 | ..... | ..... | 61 | 1,910 |
| 1921 | 280,358 | 11,737,400 | ..... | ..... | ..... | ..... |
| 1922 | 271,294 | 14,779,869 | ..... | ..... | ..... | ..... |

The output of silver in Missouri in 1922 was derived from refining pig lead. The silver was recovered from about 138,000 tons of lead concentrates.

The crude lead ore mined in the disseminated-lead district, amounting to 5,152,400 short tons, yielded 5.26 per cent of lead concentrates, which averaged 66.5 per cent of lead. The average value per ton of the lead concentrates was $54.48, compared with $41.87 in 1921, and the concentrates were slightly higher in lead content than in 1921.

The output of galena concentrates was 271,068 tons, against 280,173 tons in 1921. As several of the large producers not only mine but also smelt their lead concentrates, the values given for concentrates are to a certain extent arbitrary. The galena concentrates produced in the southwestern Missouri region, which contain a higher lead content, are sold mainly on bids from purchasers, and the prices for those concentrates are not comparable with prices given for concentrates of the disseminated-lead district.

Analyses of ores mined in the disseminated-lead district in southeastern Missouri and of the various grades of resulting concentrates are given in Mineral Resources for 1919 and 1920.

There were no shipments of zinc carbonate from southeastern Missouri during the year.

The quantity of galena recovered from shallow diggings in Washington and Jefferson counties was only 226 tons. The ore, which occurs at shallow depths in association with barytes, is mined in a small way and at odd times by the barytes miners.

Small sales of lead were made by J. C. Duckworth, of Potosi, the National Pigments & Chemical Co., and the Washington Lead Mining Co.

The 300-ton concentrating plant and the 100-ton smelter and refinery of the Missouri Cobalt Co., at Fredericktown, were not operated in 1922.

Nearly all the lead produced in southeastern Missouri was mined by the National Lead Co., St. Joseph Lead Co., Desloge Consolidated Lead Co., and Federal Lead Co. The St. Joseph Lead Co. has acquired the property of the Baker Lead Co. and that of the old Mine La Motte, which has been in a receiver's hands for several years. The St. Joseph Lead Co., though a subsidiary, has done a large amount of drilling in the Joplin region. According to the annual report of the company for 1922 the mines in southeastern Missouri produced 2,437,500 tons of crude ore, which yielded 146,431 tons of lead concentrates, and the smelter produced 105,028 tons of pig lead.

The Annapolis Lead Co.'s mine in Iron County was under development, and about 1,000 feet of drifts were cut. A complete milling plant having a daily capacity of 1,000 tons was under construction, and a steam turbine plant was completed. The property will be put into operation in 1923.

A flotation plant was added to the mill of the Desloge Consolidated Lead Co.

Some development work that yielded a small quantity of galena was done on the Eagle Picher property, near Morrellton, in Franklin County.

## OKLAHOMA.

By J. P. Dunlop.

*Mine production of lead and zinc in Oklahoma in 1922, by districts.*

| District. | Ores. | | | | | |
|---|---|---|---|---|---|---|
| | Lead concentrates (galena). | | Zinc concentrates. | | | |
| | | | Sphalerite. | | Carbonate and silicate. | |
| | Short tons. | Value. | Short tons. | Value. | Short tons. | Value. |
| Miami | 79,705 | $5,987,561 | 389,144 | $13,375,413 | ..... | ..... |
| Peoria | 11 | 925 | ..... | ..... | 50 | $450 |
| | 79,716 | 5,988,486 | 389,144 | 13,375,413 | 50 | 450 |
| Total, 1921 | 52,236 | 2,741,110 | 225,569 | 5,150,154 | ..... | ..... |

| District. | Metal content.[a] | | | |
|---|---|---|---|---|
| | Lead. | | Zinc. | |
| | Short tons. | Value. | Short tons. | Value. |
| Miami | 62,848 | $6,913,280 | 209,669 | $23,902,266 |
| Peoria | 8 | 880 | 13 | 1,482 |
| | 62,856 | 6,914,160 | 209,682 | 23,903,748 |
| Total, 1921 | 41,552 | 3,739,680 | 121,372 | 12,137,200 |

[a] In calculating the metal content of the ores from assays allowance has been made for smelting losses of both lead and zinc. In comparing the values of ore and metal it should be borne in mind that the value given for the ore is that actually received by the producer, whereas the value of the lead and zinc is calculated from the average price of all grades.

The following table gives the output of crude lead and zinc ore for the whole State of Oklahoma. Formerly it was thought advisable to calculate the tenor of crude ore and concentrates as well as assay content and value of concentrates separately for the Miami and Quapaw districts, inasmuch as the character of the ground operated in these districts had, until the new mines in the easterly extension of the Miami district, near Quapaw, were opened in 1918, differed so radically that general calculations for the State would have been valueless. Since 1921, however, there has been no necessity for such separation, as all the mills in the Quapaw district, except one in the northern part, near Hockerville, have been idle.

*Tenor of lead and zinc ore and concentrates produced in Oklahoma, 1920–1922.*

| | 1920 | 1921 | 1922 |
|---|---|---|---|
| Total crude ore milled in Oklahoma.....short tons.. | 6,943,100 | 2,969,500 | 6,159,500 |
| Miami district: | | | |
| Total concentrates in crude ore— | | | |
| Lead.....per cent.. | 1.18 | 1.76 | 1.29 |
| Zinc.....do.... | 5.87 | 7.60 | 6.32 |
| Metal content of crude ore— | | | |
| Lead.....do.... | .92 | 1.43 | 1.04 |
| Zinc.....do.... | 3.52 | 4.54 | 3.78 |
| Average lead content of galena concentrates.....do.... | 80.2 | 81.0 | 80.4 |
| Average zinc content of sphalerite concentrates.....do.... | 59.9 | 59.8 | 59.9 |
| Average value per ton— | | | |
| Galena concentrates..... | $93.93 | $52.48 | $75.12 |
| Sphalerite concentrates..... | 44.96 | 22.83 | 34.37 |
| Quapaw district: | | | |
| Total concentrates in crude ore— | | | |
| Lead.....per cent.. | 0.13 | ..... | ..... |
| Zinc.....do.... | 5.49 | ..... | ..... |
| Metal content of crude ore— | | | |
| Lead.....do.... | .10 | ..... | ..... |
| Zinc.....do.... | 3.23 | ..... | ..... |
| Average lead content of galena concentrates.....do.... | 75.6 | ..... | ..... |
| Average zinc content of sphalerite concentrates.....do.... | 58.8 | ..... | ..... |
| Average value per ton— | | | |
| Galena concentrates..... | $93.95 | ..... | ..... |
| Sphalerite concentrates..... | 42.14 | ..... | ..... |

*Mine production of lead and zinc concentrates in Oklahoma, 1891–1922, by districts.*

| District. | Lead concentrates (mainly galena). | | Zinc concentrates. | | | |
|---|---|---|---|---|---|---|
| | | | Sphalerite. | | Zinc silicate and carbonate. | |
| | Short tons. | Value. | Short tons. | Value. | Short tons. | Value. |
| Peoria | 2,177 | $106,983 | 220 | $8,289 | 2,788 | $73,882 |
| Quapaw | 4,137 | 267,196 | 35,851 | 1,546,266 | 164 | 2,692 |
| Miami | 440,758 | 33,884,202 | 1,992,065 | 85,882,959 | ..... | ..... |
| Davis | ..... | ..... | 558 | 27,399 | 899 | 24,592 |
| | 447,072 | 34,258,381 | 2,028,694 | 87,464,913 | 3,851 | 101,166 |

Mineral Resources for 1914 contains a brief history of mining in the districts in Oklahoma and also the estimated total production of each district, by years.

The total value of the lead and zinc concentrates shipped from Oklahoma in 1922 was about eight times as much as the value in 1915.

The lead and zinc deposits of northeastern Oklahoma, so far as known, are confined to Ottawa County and form the southwestern extension of the deposits in the Joplin region. There are three camps, Peoria, Quapaw, and Miami, in which extensive mining has been done, and a fourth, the Sycamore Creek district, along the Seneca fault block from 2 to 3 miles southwest of Seneca, Mo., in which considerable prospecting has been done and some ore mined. The lead and zinc deposits in southern Oklahoma are near Ravia, at the southeast end of the Arbuckle Mountains, and near Davis, Murray County, at the northwest end of the same range.

The quantity of crude ore milled in Oklahoma increased 3,190,000 tons in 1922, and the quantity of ore milled by the old mines near Commerce and at Quapaw was negligible, though more than in 1921. The value of the recoverable lead and zinc produced at mines in Oklahoma was $30,817,908, compared with $15,876,880 in 1921. The metal content of lead concentrates increased from 41,552 to 62,856 tons, and the recoverable zinc from 121,372 to 209,682 tons.

The lead concentrates produced were of slightly lower grade than those shipped in 1921. The average metal content of the sphalerite concentrates from the Miami ore has increased from 51.8 per cent in 1912 to 59.8 per cent in 1921 and 59.9 per cent in 1922, although the average zinc content of the sphalerite recovered from ore and tailings at the old mines near Commerce in 1922 was only 52 per cent.

The Oklahoma portion of the Miami region produced about 72 per cent of the total output of lead concentrates in the Joplin region. The Oklahoma shipments of sphalerite increased 163,575 tons and formed 77 per cent of the output of sphalerite from the Joplin region.

A history of the mining in the Miami district, including the output by years for 1908 to 1914 and the location of the mines and mills, was given in Mineral Resources for 1914. The reports for 1915 to 1919 contain full reviews of the production, new territory prospected, new mines opened, and new mills erected in those years. A brief description of the ore deposits in the Miami district is given in Mineral Resources for 1915.[6]

About 110 mills in the Oklahoma part of the Miami region in 1922 shipped 79,705 short tons of galena concentrates and 389,144 short tons of sphalerite concentrates, an increase of 27,471 tons of galena concentrates and of 163,638 tons of sphalerite concentrates compared with the output of 1921. The average price of the galena concentrates increased $22.64 a ton, and the average price of sphalerite concentrates, of which nearly five times as much was shipped, increased $11.54 a ton.

Many mines were idle in the beginning of 1922, but as prices for ore increased most of the plants were operated single-shift and a few double-shift. The high prices paid for galena and the increase of more than $20 a ton in the price of sphalerite permitted the mining of ore that was developed but could not be profitably extracted in 1921. The percentage of concentrates recovered was considerably less than in 1921, but the total quantity of crude ore milled more than doubled. Some drilling was done outside the proved area, but little new territory was added, though drilling disclosed new ore bodies of probable value west of territory now actively mined. Many leases expired and were renewed at a lower royalty on Indian lands. Some leases were granted directly to operators of mines, and the Quapaw Mining Co. has obtained leases on a large part of the area near Quapaw and purchased the Wolverine and other leases equipped with mills. This property will be drained and drilled when the organization of the holding company is completed. Drilling was very active in the Zincville-Hockerville area. A number of new mines were developed, several were equipped with milling plants, and some old mines were sold to new operators. Among the new mines in this area are those of the Coyne Lead & Zinc Co., mills 4

[6] Siebenthal, C. E., Zinc: U. S. Geol. Survey Mineral Resources, 1915, pt. 1, pp. 888–890, 1917.

and 5 of the St. Louis Smelting & Refining Co., and the Federal Mining & Smelting Co. (Dobson). The Texas, Blue Bonnet, and Lucky Jew mines were reopened in 1922. At Century-Douthat the J. C. Squires Mining Co. acquired the Federal, Missouri Mule, and Fort Worth mines, and the Golden Rod Mining & Smelting Co. has leased the Potosi and Leonora mines. At West Picher the Gordon Mines Co. consolidated the Zinc-Lead, Producers, Burnham, and Tiger No. 1 mines and erected a new mill. Wages were increased as prices of concentrates advanced, and mining costs decreased comparatively little, especially such large items of expenses as powder, steel, coal, and electric power.

The total quantity of crude ore milled in the Miami region in Oklahoma and Kansas in 1922 was about 8,100,000 tons, and shipments of lead and zinc concentrates exceeding $100,000 in average value were made by each of 90 companies in this region. There were more drill rigs operated and more shafts and milling plants in operation in this small area than in any other district in the United States.

Labor was plentiful and efficient. All the mines are provided with adequate shipping facilities by rail and roadway. Many additions were made to switches and sidetracks, and the Northeast Oklahoma Railroad extended its tracks several miles into Kansas.

The production in the Oklahoma part of the Miami region was that of about 110 mills, of which 4 are in the old Commerce camps and the remainder in the territory north and northeast to the Kansas State line and east to Quapaw. In the northerly extension of the Miami field in Kansas about 30 mills were in operation at different times in 1922.

The quantity of crude ore mined and milled increased from 2,969,500 tons in 1921 to 6,159,500 tons in 1922. The ore treated has showed an increase in concentrates recovered from 5.5 per cent in 1917 to 6.45 per cent in 1918, 6.6 per cent in 1919, 7.05 per cent in 1920, and 9.36 per cent in 1921, and a decrease to 7.61 per cent in 1922. The average metal content of the sphalerite was 51.8 per cent in 1912, 58.8 per cent in 1919, and 59.9 per cent in 1922.

The separate assays reported showed the zinc content to range from 52 to 63 per cent, but most of the blende assayed between 59 and 60.5 per cent. An assay of a composite sample of 4,900 samples of ore shipped in 1922 from the Miami-Blue Mound region, made by Bruce Williams, of Joplin, Mo., showed an average content of 59.2 per cent of zinc, 1.5 per cent of iron, and 1.32 per cent of lead. An assay of a composite sample of blende from 1,206 cars shipped in 1922, made by Joe J. Todd, of Miami, Okla., showed 59.8 per cent of zinc, 1.70 per cent of iron, and 0.92 per cent of lead. An assay of a composite sample of galena by Mr. Todd showed 80.9 per cent of lead. The average zinc content as computed from the reports of all the companies selling concentrates differed only 0.7 per cent from that of the composite sample.

The recovery of concentrates from all the mines averaged about 1 ton of galena to 4.9 tons of sphalerite. The proportion of galena concentrates recovered from the "dirt" mined showed wide variations in different mines, ranging from less than 1 ton of galena to 100 tons of sphalerite to 1 ton of galena to 1 ton of sphalerite.

The total shipments from those properties that may properly be classed as in the Tar River-Cardin-Douthat area, of which there

were a greater number than in the other areas, amounted to 33,869 tons of galena and 156,511 tons of sphalerite. About 2,748,700 tons of "dirt" was milled, so that the recovery in concentrate averaged about 6.93 per cent, considerably less than in 1921. A few of the mines near Cardin yielded nearly two-thirds as much galena as sphalerite; in a few mines near Douthat the proportion of galena was as little as 3 per cent, and the proportion of galena to sphalerite on the whole was less than that recovered from the mines near Picher. The proportion of galena to sphalerite recovered at all the mines in the vicinity of Douthat was about 1 ton of galena to 11 tons of sphalerite; in the Tar River section the mines yielded about 1 ton of galena to 3.6 tons of sphalerite.

The territory lying east of Picher, near the Hockerville and Zincville (St. Louis) camps, was more active than in 1921, when the shipments from 13 mines were 7,476 tons of galena and 25,881 tons of sphalerite; in 1922 the shipments from 26 mines were 10,347 tons of galena and 101,432 tons of sphalerite from 1,232,400 tons of ore treated. The sphalerite averaged about 60.4 per cent of zinc content and the galena 81.2 per cent of lead content.

The production of the mines in the vicinity of Picher showed an increase. In 1921 the quantity of ore milled was 1,093,200 tons, and the shipments were 16,468 tons of galena and 83,417 tons of sphalerite. In 1922 the quantity of ore milled was 2,158,400 tons, and the shipments were 35,080 tons of galena and 130,576 tons of sphalerite. The zinc content of the sphalerite averaged about 59.5 per cent.

At Commerce several old mines, including the Haynes, now worked by the Commerce Mining & Royalty Co., and the Emma Gordon, leased to the Incas Mining Co., were reopened and operated late in 1922. Drilling was more active than in 1919, 1920, and 1921, and the production will be larger in 1923.

The production at Peoria, the oldest mining camp in Oklahoma, was only a few tons of galena and zinc silicate mined in 1922 by small operators at shallow levels. J. P. Stoddard and G. G. McConkey, holding leases on the L. H. C. land, sunk shafts about 85 feet deep and sold a few tons of galena. Both have a considerable quantity of ore on the dump ready for milling. Mr. Stoddard has a mill which is to be operated in 1923, and Mr. McConkey is building a small plant. A new 150-ton mill on the Scott land was operated about 60 days in 1922 by lessees. Considerable zinc silicate was recovered from custom ores and ore mined by the mill owners, but only a small quantity was shipped in 1922. The total production of concentrates in the Quapaw district was small, and none of the mills near Lincolnville were in operation.

## WISCONSIN.

By J. P. Dunlop.

*Mine production of lead and zinc in Wisconsin in 1922, by districts.*

| District. | Ores. | | | | | | Metal content.[a] | | | |
|---|---|---|---|---|---|---|---|---|---|---|
| | Lead concentrates. | | Zinc concentrates. | | | | Lead. | | Zinc. | |
| | | | Sphalerite. | | Silicate and carbonate. | | | | | |
| | Short tons. | Value. | Short tons. | Value. | Short tons. | Value. | Short tons. | Value. | Short tons. | Value. |
| Benton-New Diggings. | 159 | $10,769 | 19,676 | $393,499 | ..... | ..... | 117 | $12,870 | 6,644 | $757,416 |
| Cuba City | 168 | 11,057 | 5,929 | 66,934 | ..... | ..... | 127 | 13,970 | 1,421 | 161,994 |
| Dodgeville and Highland | 104 | 8,169 | 300 | 9,000 | 562 | $7,918 | 81 | 8,910 | 294 | 33,516 |
| Mifflin and Platteville | 212 | 14,392 | 10,975 | 91,277 | ..... | ..... | 154 | 16,940 | 2,008 | 228,912 |
| Shullsburg | 299 | 17,903 | 1,915 | 32,690 | ..... | ..... | 212 | 23,320 | 585 | 66,690 |
| Total, 1921 | 942 | 62,290 | 38,795 | 593,400 | 562 | 7,918 | 691 | 76,010 | 10,952 | 1,248,528 |
| | 1,302 | 66,187 | 16,450 | 140,210 | ..... | ..... | 972 | 87,480 | 3,390 | 339,000 |

[a] In calculating the metal content of the ores from assays allowance has been made for roasting and smelting losses of both lead and zinc. In comparing the values of ore and metal it should be borne in mind that the value given for the ore is that actually received by the producer, whereas the value of the lead and zinc is calculated from the average price of all grades.

*Tenor of lead and zinc ore and concentrates produced in Wisconsin, 1920–1922.*

| | 1920 | 1921 | 1922 |
|---|---|---|---|
| Total crude ore.....short tons.. | 1,742,000 | 136,300 | 221,000 |
| Total concentrates in crude ore: | | | |
| Lead.....per cent.. | 0.20 | 0.95 | 0.43 |
| Zinc.....do.... | 5.96 | 12.07 | 11.14 |
| Metal content of crude ore: | | | |
| Lead.....do.... | .15 | .73 | .32 |
| Zinc.....do.... | 1.93 | 3.05 | 3.58 |
| Average lead content of galena concentrates.....do.... | 75.0 | 76.1 | 74.8 |
| Average zinc content of sphalerite concentrates.....do.... | 32.4 | 25.3 | 33.9 |
| Average zinc content of zinc carbonate concentrates.....do.... | 26.6 | ..... | 32.8 |
| Average value per ton: | | | |
| Galena concentrates | $92.68 | $50.83 | $66.13 |
| Sphalerite concentrates | 22.64 | 8.52 | 15.30 |
| Zinc carbonate concentrates | 21.35 | ..... | 14.09 |

The crude ore yields from 5 to more than 20 per cent of concentrates. The average recovery in concentrates decreased from 13.02 per cent in 1921 to 11.57 per cent in 1922, which was a natural reflection of the increased quantity of crude ore milled. There were no tailings treated in 1922, for it was not profitable to handle such material when raw zinc concentrates of 25 per cent grade sold for less than $10 a ton.[7] The mining methods are determined largely by the mode of occurrence of the ores but otherwise are similar to those in vogue in working the pockety ores at Joplin. The milling methods used in the Wisconsin field have been described by Walter Schultz,[8] of the Wisconsin Zinc Co.

[7] Boericke, W. F., The Crahall tailing plant: Eng. and Min. Jour., June 25, 1921, pp. 1065–1066.
[8] Schultz, Water, Milling Wisconsin lead-zinc ores: Eng. and Min. Jour., July 14, 1917, pp. 82–84.

The zinc-carbonate ore, which is mined almost entirely in the Highland and Mineral Point districts, is purchased mainly by the Mineral Point Zinc Co. and made into zinc oxide in the plant at Mineral Point, Wis. Some carbonate ores were produced, and the sales in 1922 were 562 tons.

The metal content of the raw sphalerite concentrates shipped by the mines ranged from 21.4 to 45 per cent, but nearly half of the concentrates sold ranged between 22 and 28 per cent. The zinc content of the roasted sphalerite concentrates shipped was from 59 to 60 per cent.

The value of the mine output of lead and zinc in Wisconsin was $1,324,538, against $426,480 in 1921. The lead concentrates sold decreased from 1,302 tons in 1921 to 942 tons in 1922, and the sphalerite concentrates sold increased from 16,450 to 38,795 tons. The metal content of the lead concentrates was 281 tons less than in 1921. The recoverable zinc content of the sphalerite and zinc-carbonate concentrates increased 7,562 tons.

Very little development work was done, and very few new mines were opened.

The lead and zinc mines of Wisconsin are in Grant, Iowa, and Lafayette counties and contain the most valuable part of the ore deposits of the upper Mississippi Valley region, a historical review of which is given in the Illinois section of this report in Mineral Resources for 1914. A detailed description of the Wisconsin lead and zinc districts and of the mines in each district to the year 1906 is given by Bain.[9] The development of the mines subsequent to Bain's report and the output of Wisconsin mines have been given in Mineral Resources for 1907 to 1921.

Roasting and electromagnetic separation have been utilized in the district for many years to produce a marketable zinc product. Comparatively few of the concentrating plants are equipped with roasters, but practically all the larger mining interests own or control separating plants.[10] The roasting and separating plants operated in Wisconsin in 1922 were those of the National Zinc Separating Co., at Cuba City, and the Mineral Point Zinc Co., at Mineral Point. The shipments made came from about 30 mines, many of which were small and were operated spasmodically.

Approximately 48,300 tons of sphalerite concentrates were shipped in 1922 from mines in the upper Mississippi Valley region (Illinois and Wisconsin), and practically all of this material was treated at roasting and separating plants in Wisconsin. The average zinc content of the raw sphalerite concentrates from Wisconsin sold in 1922 was 33.9 per cent, and the average price per ton was $15.30; the corresponding content and price for 1917 were 32.8 per cent and $29.48; for 1918, 34.6 per cent and $25.70; for 1919, 35.3 per cent and $21.90; for 1920, 32.4 per cent and $22.64; and for 1921, 25.3 per cent and $8.52.

The percentage of concentrates recovered from crude ore is much higher in Wisconsin than in the Joplin region, but the assay of the raw zinc concentrates averages 21 to 42 per cent less in zinc content. The

[9] Bain, H. F., Zinc and lead deposits of the upper Mississippi Valley: U. S. Geol. Survey Bull. 294, pp. 81–148, 1906.

[10] Deutman, E. G., The roasting and magnetic separation of Wisconsin zinc ores: Eng. and Min. Jour., June 28, 1919, pp. 1107–1111.

new concentrating plants are equipped with more tables than formerly. The concentrates from the tables have a very high iron content, but this can be remedied by roasting.

Very few of the properties equipped with milling plants were operated steadily in 1922, and the demand and price for zinc concentrates were not sufficiently attractive to induce mining or development by either large or small operators. The high prices late in 1922 enabled holders of stored sphalerite concentrates to resume shipment, and some zinc carbonate was mined and shipped from Highland, although the quantity was small compared with former years. None of the mines owned by the Mineral Point Zinc Co., Wisconsin Zinc Co., or Frontier Mining Co. were operated in 1922, but shipments of raw and roasted concentrates amounting to about 14,400 tons were made from these properties and from those of the Blockhouse Mining Co., Rodham McQuitty Mining Co., and McKinlay Bros. The larger mines and mills operated in 1922 were the Fields Meloy and Nightingale, at New Diggings; the Zinc Hill and Connecting Link, at Cuba City; and the Dale Rundell, at Mifflin. Small shippers were the Imperial and M. & P., at Shullsburg. The Vinegar Hill Zinc Co. was the only one that operated several mines throughout 1922. The concentrates from its mines and most of the raw concentrates made at other plants were shipped to the National Zinc Separating Co.'s plant at Cuba City.

Exclusive of shipments of concentrates recovered in 1920 and 1921 the mines in Wisconsin produced and shipped about 25,000 tons of zinc concentrates in 1922, nearly all of which was recovered from the Dale Rundell, Connecting Link, Zinc Hill, and Nightingale mines.

For description of the old mines and concentrating plants on which no essential changes were made during 1922 the reader is referred to Mineral Resources for recent years.

# TIN.

By Bertrand Leroy Johnson.

## PRODUCTION AND DEVELOPMENT.

Tin ore was mined in the United States in 1922 only in Alaska, South Dakota, and New Mexico. Tin-bearing concentrates were obtained only from Alaska.

*Tin mined in the United States (including Alaska), 1915–1922, in short tons.*

[Metallic tin obtainable from concentrates produced in tin-mining.]

| | | | |
|---|---|---|---|
| 1915 | 102 | 1919 | 56 |
| 1916 | 140 | 1920 | 22 |
| 1917 | 110 | 1921 | 4 |
| 1918 | 69 | 1922 | 1.4 |

*Alaska.*[1]—No tin ore was mined in the York district of Seward Peninsula in 1922, and the small output of Alaskan tin-bearing concentrate (2.3 short tons) was obtained entirely from the Hot Springs district of the Tanana region, where it was recovered incidentally to gold-placer mining. The recoverable content of the metallic tin in the concentrate produced was about 1.4 short tons.

*South Dakota.*—The National Tin Corporation is reported to have done 1,400 feet of underground development work from the 100-foot levels on its property near Hill City, S. Dak., consisting of 1,000 feet of drifts on the Tin Boom claim and 400 feet of drifts on the Mohawk. In addition the Cowboy shaft was retimbered from the 100-foot level. In the drifting on the Tin Boom five ore bodies from 2 to 6 feet in width and carrying about 2 per cent of cassiterite are said to have been cut. No ore was struck in the work on the Mohawk. Eighteen men were employed on the property from June to October. The company suspended operations for the year in November.

The Rare Minerals Co. is said to have had five men engaged for about three months in development work on its properties near Oreville, S. Dak. John Foster did some development work on his tin properties near Berne Station, S. Dak., and John White on his placer-tin ground on Potato Creek.

*New Mexico.*—About 70 feet of development work is reported to have been done on several showings of tin ore ranging from a streak to 4 inches in width on the Beaver Head group on Beaver Creek, Catron County, N. Mex.

[1] Data regarding the Alaska tin-mining industry were obtained from Alfred H. Brooks, of the U. S. Geological Survey.

## SMELTING INDUSTRY.

Two tin-smelting plants in operation in the United States produced 9,108 short tons of metallic tin in 1922, wholly from Bolivian concentrate. The producing smelters were those of the American Smelting & Refining Co., Perth Amboy, N. J., and the Williams Harvey Corporation, Brooklyn, N. Y. The smelting of imported tin-bearing concentrate in the United States was begun in 1916.

*Smelter output of metallic tin in the United States, 1916–1922, in short tons.*

| | | | |
|---|---|---|---|
| 1916 | 2,261 | 1920 | 17,652 |
| 1917 | 6,065 | 1921 | 11,542 |
| 1918 | 10,284 | 1922 | 9,108 |
| 1919 | 12,236 | | |

## IMPORTS AND EXPORTS.[2]

*Tin concentrate imported into the United States, 1915–1922.*

[General imports.]

| Year. | Short tons. | Value. | Year. | Short tons. | Value. |
|---|---|---|---|---|---|
| 1915 | 552 | $182,950 | 1919 | 19,196 | $11,871,948 |
| 1916 | 8,040 | 4,032,460 | 1920 | 34,148 | 18,795,162 |
| 1917 | 9,054 | 4,743,099 | 1921 | 15,340 | 5,672,861 |
| 1918 | 18,394 | 11,444,401 | 1922 | 13,804 | 5,504,434 |

*Tin imported as metal and entered for consumption in the United States, 1915–1922.*

| Year. | Short tons. | Value. | Year. | Short tons. | Value. |
|---|---|---|---|---|---|
| 1915 | 57,792 | $38,736,909 | 1919 | 44,849 | $50,890,019 |
| 1916 | 69,035 | 51,802,232 | 1920 | 62,795 | 73,440,872 |
| 1917 | 72,166 | 63,860,340 | 1921 | 27,101 | 16,645,719 |
| 1918 | 71,254 | 93,144,218 | 1922 | 67,416 | 40,797,986 |

The details of the general imports of tin concentrate and metallic tin for 1922 are given in the following table. The real origin of the concentrate and metal is not disclosed by this table, for it indicates only the countries from which the shipments were made direct to the United States. Many of the figures represent reexports, the concentrates credited as exported from Chile and Peru coming originally, in all probability, from the tin mines of Bolivia.

[2] Statistics of imports and exports compiled from the records of the Bureau of Foreign and Domestic Commerce by J. A. Dorsey, of the U. S. Geological Survey.

*Tin concentrate and metallic tin imported into the United States in 1922.*

[General imports.]

| Country. | Tin concentrate. | | Metallic tin as bars, pigs, blocks, grains, and granulated. | |
|---|---|---|---|---|
| | Short tons. | Value. | Short tons. | Value. |
| France | | | 56 | $36,383 |
| Netherlands | | | 494 | 293,190 |
| England | 41 | $8,086 | 10,143 | 6,363,246 |
| Canada | 77 | 23,893 | 35 | 19,597 |
| Bolivia | 1,013 | 300,455 | | |
| Chile | 12,507 | 5,098,531 | | |
| Ecuador | | | 28 | 16,557 |
| Peru | 110 | 37,882 | | |
| British India | | | 90 | 52,562 |
| Ceylon | | | 140 | 87,078 |
| Straits Settlements | 56 | 35,575 | 47,346 | 28,437,861 |
| China | | | 493 | 320,448 |
| Java and Madura | | | 3,167 | 1,906,777 |
| Other Dutch East Indies | | | 84 | 52,807 |
| Hongkong | | 12 | 4,771 | 2,865,397 |
| Japan | | | 28 | 18,047 |
| Australia | | | 541 | 328,036 |
| | 13,804 | 5,504,434 | 67,416 | 40,797,986 |

*Exports of metallic tin from the United States, 1919–1922, in short tons.*

| Year. | Domestic.[a] | Foreign.[b] |
|---|---|---|
| 1919 | 306 | 76 |
| 1920 | 706 | 333 |
| 1921 | 1,154 | 406 |
| 1922 | 901 | 329 |

[a] Imported as ore and exported as pigs, bars, etc.
[b] Imported as pigs, bars, etc., and exported as such.

The exports of tin concentrate were insignificant and were not recorded.

## CONSUMPTION.

The quantity of new (primary) tin made available for consumption in the United States during any year may be obtained by adding the general imports of metallic tin to the quantity of tin produced in the United States and subtracting from the result the sum of the domestic and foreign exports of metallic tin.

*New tin made available for consumption in the United States, 1920-1922, in short tons.*

| | |
|---|---|
| 1920 | 79,632 |
| 1921 | 37,083 |
| 1922 | 75,294 |

The quantity of this new tin actually consumed in the United States during a given year is not susceptible of accurate determination, as a close estimate of the annual consumption is not possible without a knowledge of the stocks in various hands in this country.

## PRICES.

The average price of Straits tin in New York in 1922 was 32.58 cents a pound, as compared with 30 cents in 1921.[3] The course of the market during the year is shown in the following table:

*Average monthly prices, in cents per pound, of Straits tin in New York in 1922.*[3]

| | | | | | |
|---|---|---|---|---|---|
| January | 32.11 | May | 30.97 | September | 32.41 |
| February | 30.82 | June | 31.54 | October | 34.64 |
| March | 29.17 | July | 31.82 | November | 36.72 |
| April | 30.65 | August | 32.44 | December | 37.68 |

The average price for the year in London was £159 10s. 9d. a ton of 2,240 pounds. The lowest price was £139, and the highest price was £187⅞.[4]

[3] Metal Statistics, 1923, p. 325.
[4] Idem, p. 331.

# SECONDARY METALS.

By J. P. Dunlop.

## INTRODUCTION.

### SCOPE OF REPORT.

"Secondary metals" are those recovered from scrap metal, sweepings, skimmings, and drosses and are so called to distinguish them from metals derived directly from ores, which are termed "primary metals." The distinction does not imply that secondary metals are of inferior quality, for metals derived either from ore or from waste material vary in purity and in adaptability to use in making certain products. The reports to the United States Geological Survey now include secondary copper, zinc, lead, tin, antimony, aluminum, and nickel. The figures obtained by the Survey are supplemental to those on primary metals and are given to enable producers and consumers to form a more comprehensive idea of the quantities of metal available for consumption; in fact, they constitute an essential addition to those given in the seven general reports on primary metals.

### RECOVERY OF WASTE MATERIAL.

The collection of waste material is a regular branch of industry involving the gathering, sorting, and shipping of waste of an estimated value of more than a billion dollars yearly. The industry is far removed from its humble origin, typified by the lusty-lunged junkman, for it is now an important, unified, progressive, and honest trade—an immense industry with many ramifications and an enormous volume of business which grows year by year and is conducted with increasing efficiency and increasing benefit to the country.

The flow of material from large plants was not interrupted by the prevailing low prices of waste material in the first part of 1922, but the collecting of scrap metal and other waste material by itinerant dealers in country districts has been greatly reduced, because the high cost of transportation and sorting absorbed most of the profit. Metallic scrap eventually reaches the market, and a reduction in the cost of labor and in freight rates in 1923 would make scrap accumulated in country districts available for use. Shipments from country districts were negligible in 1922, and large manufacturing plants, railways, and Government stocks furnished nearly all waste scrap marketed.

There has been an abundant supply of scrap metal in Great Britain, France, and Germany, which has undoubtedly affected the consumption of new metal in those countries. The supplies of waste metal, especially brass, were larger than had been estimated. These supplies have been greatly depleted by use and by exports. In 1922 the exports of brass and copper scrap from Europe to the United States were more than 82,000 short tons, nearly four times as great as the exports in 1921. They continued large during the first part of 1923. The offerings of scrap metals and surplus stocks of new metals by the War and Navy departments of the United States have shown that the quantities of such material on hand at the end of the war were greatly underestimated. Such stocks undoubtedly affected prices of scrap metal in 1922 and reduced the consumption of new metals. The following article by W. M. Corse, chairman of the division of research extension of the National Research Council, published in Brass World, May, 1923, emphasizes the importance of remelted material to metal users and producers:

SECONDARY NONFERROUS METALS.

By W. M. Corse.

The United States Geological Survey tells us that the value of secondary metals in 1921 was $89,140,500. Its weight was 436,768 tons. The economic importance of the subject immediately becomes apparent. The term "secondary metal" means "reworked" or "reconditioned" material. This product is offered in the form of scrap, turnings or borings, and ingot. While some secondary metal from wrought stock can be secured in the market, much of this class of material goes directly to the rolling mill from which it came. This is because of the tonnage involved in large-scale operations and because of its known composition and quality. Naturally, the turnings or borings find their way to the smelter because of the uncertainty of the composition in most instances.

The value of brass is so well known that practically all of it finds its way first to the small dealer, then the jobber, and finally to the smelter. To those of us who are familiar with the brass-foundry business it is not necessary to call attention to the value of secondary metals either from a buyer's or seller's standpoint. But it may not be amiss to emphasize the fact that more savings can be made in the handling and recovery of metal values than many of us realize. This is not as true to-day as it was even 10 years ago, but if we look back 20 years we see many concerns failing to realize the value of sweepings, ashes, and other forms of metal-bearing refuse. Many of our brass foundries to-day can afford to install a simple outfit for the recovery of metallic waste. The last installation that was made under my direction was in 1921 and cost approximately $3,000. The metal recovered paid for the entire equipment during the first year. It consisted of a special form of ball-mill crusher with automatic discharge connected with a concentrating table. The product consisted of three grades of material—first, large pieces of metal that would not pass a one-fourth inch sieve; second, a concentrate carrying about 65 to 75 per cent metal; and, third, a tailing running under 1 per cent of metal. The first could be melted in any quantity in the foundry; the second was added in small quantities to the charge; the third was sent to the dump.

Some concerns prefer to insert a jig for some of the intermediate operations after the crushing operation. By this method a product is produced which can be used directly in certain proportions, thereby reducing the amount of fine material to be handled by the concentrating table. Automatic handling equipment may be installed with profit in some cases, but the average foundry needs nothing more than the crusher, jig, and table combination. There are a few concerns who specialize in this equipment and can furnish advice as to the best type for any particular plant. Special conditions may make it seem advisable to sell metal-bearing refuse direct to the smelter, but as a general thing I believe it will pay to have a recovery plant, even though the concentrates are later sold. It does not usually pay to attempt to concentrate to too great an extent, because the loss in the tailings more than offsets the difference in values. Some smelters estimate that a concentrate of between 20 and 30 per cent metal is the most economical for the small recovery plant.

Foreign or purchased scrap, the first of the three kinds of secondary metals mentioned above, consists of pieces of metal of crucible size or above. It is usually offered for sale in sorted lots, depending on the kind of casting the foundry is producing. So many variations in grading are possible that only experience can determine the advisability of using this variety. Like all of the three kinds, its principal advantage is saving in cost.

Turnings or borings, because of their nature, offer some advantages and some disadvantages over foreign scrap. Nonmetallic contents are not so easily detected, but the possibility of constant composition through careful mixing is an advantage. High melting loss when used directly, combined with the possibility of excess oxide inclusions, make two meltings desirable. The first of these is best done by the smelter. In large plants the smelter may be a department of the foundry, but it is usually a separate concern.

The addition of clean mixed borings of known composition may be made to the melt direct, but as many plants have sufficient of this class of material from their own machine shops it is not usually practiced. The slowing down of the melting time by adding borings is sometimes a disadvantage. In some cases turnings are cabbaged and borings are briquetted. This may result in a slight reduction in melting loss, but the principal advantage is in the time saved in handling.

The third form of secondary metal is ingot brass. Twenty years ago this product was in disrepute, but gradually better production methods have improved the quality of the product so that now the use of a high-grade brass ingot is considered good practice by many of our most exacting foundries. Raw material which can not be used directly can be smelted in a reverberatory furnace, brought to formula, and cast into ingot. This method does not usually produce as good quality as when clean turnings are melted with the addition of scrap copper or tin to bring to formula. Sometimes a combination of reverberatory furnace ingot can be made with turnings and scrap copper to produce good quality metal. The quality of product depends largely on the knowledge and skill possessed by the smelter. Careful, intelligent, and honest methods can bring good results. The advantages of a good brass ingot over other kinds of secondary metal are saving in time in handling, saving in time of melting and consequently of fuel, uniformity of composition, and lower costs. The increased use of brass ingot demonstrates that the above advantages are being realized by progressive manufacturers.

One advantage of the expert use of secondary metal is that such metals, normally carrying elements classed as impurities, may be mixed so as to take advantage of these impurities in another composition in which they are normal or necessary constituents. For example, cupro-nickel scrap may be added to mixtures for nickel-bronze, and iron-bearing yellow brass may be transformed into manganese bronze. The latter is described in a paper by P. E. McKinney, entitled "Manganese bronze," presented before the American Institute of Mining and Metallurgical Engineers in February, 1919. I wish to emphasize one important point. In order to get the best results, it is necessary to employ the utmost laboratory control of raw materials, primary and secondary, particularly the latter.

It seems to be the case with some foundries that secondary metal produces hard spots in the castings. Careful inquiry at the United States Naval Gun Factory revealed the fact that they have less trouble with machining when using secondary metal. This confirms the statement that careful laboratory control pays good dividends.

The American Society for Testing Materials, the leading society in the preparation of specifications for engineering materials, has issued specifications on the following nonferrous compositions in ingot form: Manganese bronze; composition "G," U. S. N.; bronze-bearing metal (six formulae); brass ingot metal (seven formulae). These have been carefully prepared by committees of experts and represent the leading thought on the subject to-day.

Besides the alloy compositions in secondary form, we also have scrap copper, tin, lead, zinc, aluminum, and nickel alloys. Some forms can be used directly, and others go to the smelter. Casting copper is the product of the reverberatory furnace, using secondary metal as a raw material. It usually runs over 99 per cent copper contents. Re-run aluminum ingot made from secondary metals is a regular product to-day, and with better knowledge of this metal its quality is improving. Probably the largest amount of secondary aluminum finds its way back to the smelter of the virgin metal, because the melting losses due to oxides make it difficult material to handle by such methods as are employed with brass.

Because of the special nature of monel metal and pure nickel, the market for these in secondary form is somewhat limited. A certain percentage finds its way to the foundries, but monel metal may get mixed with nickel silver, thus introducing

zinc when possibly not wanted. It is probably better to communicate with the producers than to handle through scrap dealers. The development and research department of the International Nickel Co., New York City, can advise regarding the best methods of disposal or purchase of this class of material.

Many people have the idea that no casting made from a melt containing secondary metal can possibly be as good as when all primary metal is used. If such people could have the privilege of visiting the brass foundry of the United States Naval Gun Factory at the navy yard in Washington and see what is being done there, I think they would be surprised. Stimulated somewhat by the policy of the Navy to rework its own scrap, the metallurgists there have produced regularly castings that have passed all Navy specifications from melts consisting principally of secondary metals. Inspection of every heat precludes any doubt about this result. It shows what can be done when intelligent, careful control is practiced by the metallurgist, coupled with an excellent working knowledge of foundry conditions. If more of our people realized how much scientific research in many branches owes to the painstaking and careful work done by the men in the various naval departments, they would see that the industrial value of the Navy Department goes a long way toward paying its cost to the country.

I have tried to outline the various forms of secondary nonferrous metal with particular reference to the brass foundry and have shown the economic value of an intelligent use of these materials. Reliable concerns can furnish good metal, and by its use good castings can be produced. The reference to the United States Naval Gun Factory is one of the best examples of the practice carried to a high degree of perfection.

The chapters on secondary metals in Mineral Resources for 1918 and 1919 contain much information regarding the collection of waste material. Various trade papers, such as the Waste Trade Journal, Daily Metal Trade, Raw Material, Brass World, American Metal Market, Foundry Iron Age, Iron Trade Review, Metal Industry, and Daily Metal Reporter, also contain valuable information relating to prices and marketing of scrap metal and drosses and technical information relating to the proper use of old metals. Some idea of the questions to which replies are given by technical and trade papers are set forth in a statistical survey of difficulties encountered by nonferrous foundries over a period of years, by Adolph Bregman, published in Metal Industry, July, 1922, page 269.

## CLASSIFICATION OF OLD METALS.

The classification of old metals drawn up by the metal division of the National Association of Waste Material Dealers (Times Building, New York City) and changed from time to time as was found desirable has become the standard with both dealers and manufacturers all over the United States. Its latest classification (circular I) is effective until July 1, 1924, when a new circular will be issued. The metal division, as well as all other divisions of the association, has a grievance committee, whose duty it is to adjust differences between members or to arrange for arbitration if it becomes necessary. This division has in recent years been able to remedy trade abuses, and its constructive work has attracted to it practically all dealers in metal wastes. The present classification follows:

*Standard classification for old metals, effective from July 1, 1923, to July 1, 1924.*

1. Delivery:

(*a*) Delivery of more or less on the specified quantity up to 2½ per cent is permissible.

(*b*) If the term "about" is used, it is understood that 5 per cent more or less of the quantity may be delivered.

1. Delivery—Continued.

(*c*) Should the seller fail to make deliveries as specified in the contract, the purchaser has the option of canceling all of the uncompleted deliveries or holding the seller for whatever damages the purchaser may sustain through failure to deliver, and if unable to agree on the amount of damages, the arbitration committee of the National Association of Waste Material Dealers (Inc.), appointed for this purpose, to determine the amount of such damages.

(*d*) In the event that buyer should claim the goods delivered on a contract are not up to the proper standard, and the seller claims that they are a proper delivery, the dispute shall be referred to the arbitration committee of the National Association of Waste Material Dealers (Inc.), to be appointed for that purpose.

(*e*) A contract for a carload, unless otherwise agreed upon, shall mean the minimum quantity recognized by the official classification tariff of the district in which the seller is located.

(*f*) A ton shall be understood to be 2,000 pounds, unless otherwise specified.

(*g*) If, through embargo, a delivery can not be made at the time specified, the contract shall remain valid and shall be completed immediately on the lifting of the embargo, and terms of said contract shall not be changed.

(*h*) In case of a difference in weight and the seller is not willing to accept buyer's weights, a sworn weigher shall be employed and the party most in error must pay the costs of handling and weighing.

2. Heavy copper:

This shall consist of copper not less than one-sixteenth inch thick and may include trolley wire, heavy field wire, heavy armature wire, that is not tangled, and also new copper clippings and punchings, untinned and clean, and copper segments that are clean.

3. No. 1 copper wire:

To consist of clean untinned copper wire not smaller than No. 16 B. & S. wire gage, to be free from burnt copper wire which is brittle and all foreign substances.

4. No. 2 copper wire:

To consist of miscellaneous clean copper wire such as of necessity would be taken out of the heavy copper and the No. 1 copper wire, but to be free of hair and burnt wire which is brittle.

5. Light copper:

Shall consist of the bottoms of kettles and boilers, bathtub linings, hair wire, burnt copper wire which is brittle, roofing copper and similar copper, free from radiators, brass, lead, and solder connections, readily removable iron, old electrotype shells, and free of excessive paint, tar, and scale.

6. Composition or red brass:

Shall consist of red scrap brass, valves, machinery bearings, and other parts of machinery, including miscellaneous castings made of copper, tin, zinc, and/or lead, no piece to measure more than 12 inches over any one part, not to weigh over 60 pounds, to be free of aluminum and manganese, also free of railroad boxes, cocks and faucets, gates, pot pieces, ingots, and burned brass.

7. Railroad bearing:

Shall consist of railroad boxes or car-journal bearings, must be old standard used scrap, free of yellow boxes, plastic and similar bearings, also iron-backed boxes, and must be free of babbitt; also free of excessive grease and dirt.

8. Cocks and faucets:

To be mixed red and yellow, free of gas cocks and beer faucets; shall be at least half red.

9. Heavy yellow brass:

Shall consist of heavy brass castings, rolled brass, rod brass ends, brass screws, and tinned or nickel-plated brass tubing; to be free of iron and dirt, and must be in pieces not too large for crucibles; no piece to measure more than 12 inches over any one part. Must also be free of aluminum and manganese mixtures. Condenser tubes shall not be considered as heavy brass.

10. Light brass:

Shall consist of light sheet brass, forks and spoons, miscellaneous brass that is too light for heavy, to be free of any visible iron, radiators, gun shells containing paper, ashes, or iron, loaded lamp bases, and clock works.

11. New brass clippings:

Shall consist of the cuttings of new sheet brass, to be absolutely clean and free from any foreign substances.

12. Brass tubing:
Shall consist of brass tubing, free of nickel plating, tinned, soldered, or tubes with cast-brass connections. To be sound, clean tubes, free of sediment, and condenser tubes.
13. No. 1 composition turnings:
To be free of aluminum, manganese, plastic, and yellow brass turnings, not to contain over 2 per cent iron, to be free of grindings or foreign material, especially babbitt, and free from adulterations made to resemble metal. Turnings not according to this specification subject to sample.
14. No. 1 yellow brass turnings:
Shall consist of strictly rod turnings, free of aluminum, manganese, composition, and tobin turnings. Not to contain over 3 per cent of iron, oil, or other moisture, to be free of grindings and babbitts. To avoid dispute, to be sold subject to sample.
15. No. 1 pewter:
Shall consist of tableware and soda-fountain boxes, but in any case must test 84 per cent tin. Siphon tops to be treated for separately.
16. Auto radiators:
To be classed separately must be free from iron.
17. Zinc:
Must consist of clean sheet and cast zinc, also cast batteries, to be free of loose oxide and dross, sal ammoniac cans, and other foreign materials.
18. Tin foil:
Shall consist of pure foil free of lead compositions and other foreign ingredients and matters.
19. Electrotype shells:
Must be hand picked and free of loose dross and chunks of dross.
20. Battery lead plates:
Shall consist of dry-battery lead plates, allowance to be made for wood, rubber, moisture, and paper, moisture not to exceed 1 per cent.
21. New sheet aluminum clippings:
Shall consist of new sheet aluminum and cuttings. Must be free from oil, grease, and any other foreign substances. Must be guaranteed not less than 98 per cent pure aluminum.
22. Aluminum wire:
Shall consist of aluminum wire guaranteed 98 to 99 per cent pure aluminum and must be free from corrosion and any other foreign substance.
23. Painted sheet aluminum:
Shall consist of painted sheet aluminum and must be absolutely free from iron, dirt, or any other foreign substance.
24. Aluminum castings:
Shall consist of aluminum castings, free from iron, babbitt, brass, and any other foreign substance. Must not exceed 2 per cent of oil and grease.
25. Old sheet aluminum:
Shall consist of old and manufactured sheet aluminum. Must be free from painted sheet aluminum, iron, dirt, and any other foreign substance.
26. Aluminum borings:
To avoid dispute, should be sold subject to sample.
27. Aluminum foil:
Shall consist of pure aluminum foil, free from paper and any foreign ingredients.
28. Babbitt metal:
Shall contain bearing metal of all kinds. Shall not contain scrap hard metal, Allen metal (which is copper and lead alloy), die cast, zinc boxes, or type metal.
29. Monel metal scrap:
Must be in sheets, clippings, castings, bars, or rods. Must be free of iron and other foreign materials. To avoid disputes, to be sold subject to sample.
30. Monel metal turnings:
Must be free of iron and undue percentage of oil and moisture. To avoid disputes, to be sold subject to sample.
31. Packages:
Shall be good strong packages, suitable for shipment, and each package to be plainly marked with the gross and tare weights so that when packages reach their destination their weights can be easily checked.
When goods are not packed according to the above specifications and shipper wants his rejections returned, the cost of labor shall be charged to the shipper.

## REVIEW OF THE SECONDARY-METAL INDUSTRY IN 1922.

### MARKET CONDITIONS.

Increased consumption and higher prices were universal in the market for scrap metals in 1922 as compared with 1921. The quantities of scrap metal utilized, as shown by the table on page 182, were very much greater than in 1921, and the values increased in about the same ratio. There were fewer financial losses in the trade than in 1921, because little scrap was handled on a speculative basis, and the material purchased early in 1922 was obtained at prices so low that it could be held for a sure profit when business conditions should improve. The general liquidation that began late in 1920 continued during 1922. Foundries and other consumers of metal had a larger demand for their products, and consequently they bought more, but usually only when sale contracts required to be filled. Hand to mouth buying prevailed, and competition for small orders made profits small but better than in 1921. War scrap of all descriptions, particularly cartridge cases and brass scrap, domestic and imported, was plentiful, and more scrap metal and surplus new metal was offered by Government bureaus than had been expected.

Considerable quantities of scrap metals were sold directly to consumers and were not handled by dealers. In brass scrap there was considerable competition from foreign sources. During the first half of 1922 business was only slightly better than in 1921, for railway and coal strikes hampered shipments and reduced consumption, and the prices of new metals were low. In the second half of 1922 the large increase in building operations and the much greater activity in the automobile industry stimulated the demand and raised the prices for scrap metals. As there were smaller stocks, foreign and domestic, of white metal than there were of brass composition, the demand was more active for tin, zinc, and lead than for alloys composed mainly of copper. The domestic consumption of metals increased rapidly, and as consumers had for a year been buying only sufficient new and old metals for their reduced output, and the larger metal consumers had utilized most of their large supplies of scrap accumulated during the war, there was an active demand for scrap metals. Supplies of new lead were scarcer, and the quantity consumed in the automobile and paint trades was very large. Increased consumption of lithopone and zinc dust created a larger outlet for zinc drosses and skimmings, which was supplemented by a revival of the demand for exports.

The buying of scrap metals was limited mainly to manufacturing requirements and was hampered by high freight rates and uncertain deliveries. The waste metals marketed were mainly those of the factory and business areas, for country collections of old metals will not reach pre-war efficiency and volume until the cost of collection and transportation becomes lower. An editorial in the Waste Trade Journal, February 10, 1923, says that country collections are 50 per cent less than before the war, and that the collection of domestic and foreign waste is and will remain comparatively small, because of the restrictions placed on the immigration of persons of the class who usually follow this occupation, which is disdained by native Americans or Americanized immigrants.

It is not probable that many dealers in waste metals had a very prosperous business in 1922 as a whole. Trade was good late in the year, however, and the prospect for 1923 was favorable for a larger and more profitable business.

Dealers in and refiners and smelters of scrap metals and drosses handled very much more secondary material than in 1921, and the value of the secondary metals covered in this report increased about $54,750,000.

## PRICES.

The dealers' average buying prices at New York of heavy scrap copper decreased from 11.10 cents a pound in January, 1922, to 10 cents a pound in March, when the turn of the market was reached, and prices advanced to 11.25 cents in May. A decline to 11 cents occurred in July, but prices again advanced in August and reached 11.75 cents in September. The price declined to 11 cents for a few days in October and then steadily advanced to the closing figure of 12.40 cents in December.

No. 1 composition scrap showed a wider and more unstable range of prices, opening at 8.1 cents in January and selling for 7 cents, the lowest price of the year, the last week in February. Thereafter prices increased, with minor fluctuations, to 9.65 cents, the highest price of the year, in December.

The price of heavy scrap lead opened the year at 4.10 cents a pound and reached 3.90 cents, the lowest quotation of the year at the end of January. In June 4.75 cents a pound was paid, and after July the price was never lower than 4.8 cents. The maximum of 6.50 cents was reached in December, and the closing price was 6.10 cents. The range of price during the year (2.6 cents) was much greater than usual.

The variation in the price of scrap zinc was nearly 3 cents—also an unusual range. It opened at 2.5 cents a pound in January and sold for as little as 2 cents in April and May, though a sharp advance occurred late in May. The highest price of the year (4.75 cents) was reached in November, and the closing price was 4.40 cents.

The price of secondary tin followed the trend of prices for primary tin, and black tin pipe was quoted as high as 33.5 cents in December and as low as 26 cents in February. The prices of scrap aluminum and No. 12 alloy were subject to wide fluctuations, for the quotations for scrap aluminum castings ranged from 9.25 cents at the beginning of 1922 to 17 cents in November and December.

*Average scrap-metal prices, 1922, in cents per pound.*[a]

[New York dealers' weekly average buying prices.]

| | Heavy copper. | No. 1 composition. | Heavy lead. | Scrap zinc. | | Heavy copper. | No. 1 composition. | Heavy lead. | Scrap zinc. |
|---|---|---|---|---|---|---|---|---|---|
| Jan. 7 | 11.10 | 8.10 | 4.10 | 2.50 | July 1 | 11.25 | 8.25 | 4.00 | 3.00 |
| 14 | 11.00 | 8.10 | 4.10 | 2.50 | 8 | 11.25 | 8.00 | 4.00 | 3.00 |
| 21 | 11.00 | 8.10 | 4.10 | 2.50 | 15 | 11.25 | 8.00 | 4.00 | 3.10 |
| 28 | 10.90 | 7.90 | 3.90 | 2.40 | 22 | 11.25 | 8.00 | 4.00 | 3.40 |
| Feb. 4 | 11.10 | 7.75 | 3.90 | 2.50 | 29 | 11.00 | 8.00 | 4.80 | 3.55 |
| 11 | 10.65 | 7.75 | 3.90 | 2.10 | Aug. 5 | 11.00 | 8.50 | 4.80 | 3.00 |
| 18 | 10.50 | 7.75 | 3.90 | 2.40 | 12 | 11.00 | 8.50 | 4.80 | 3.00 |
| 25 | 10.25 | 7.00 | 3.90 | 2.50 | 19 | 11.55 | 8.50 | 4.90 | 3.00 |
| Mar. 4 | 10.25 | 7.00 | 3.90 | 2.50 | 26 | 11.60 | 8.50 | 4.90 | 3.00 |
| 11 | 10.50 | 7.75 | 4.00 | 2.40 | Sept. 2 | 11.60 | 8.00 | 4.90 | 3.00 |
| 18 | 10.00 | 7.90 | 4.10 | 2.40 | 9 | 11.60 | 8.00 | 4.90 | 3.00 |
| 25 | 10.00 | 7.90 | 4.10 | 2.40 | 16 | 11.60 | 8.00 | 5.00 | 3.00 |
| Apr. 1 | 10.50 | 7.75 | 4.10 | 2.40 | 23 | 11.60 | 8.00 | 5.10 | 3.90 |
| 8 | 10.50 | 7.75 | 4.50 | 2.40 | 30 | 11.75 | 8.00 | 5.40 | 4.10 |
| 15 | 10.50 | 7.75 | 4.50 | 2.40 | Oct. 7 | 11.75 | 8.75 | 5.40 | 4.10 |
| 22 | 10.50 | 7.75 | 4.25 | 2.50 | 14 | 11.75 | 8.75 | 5.00 | 4.10 |
| 29 | 10.50 | 7.75 | 4.40 | 2.00 | 21 | 11.75 | 8.75 | 5.00 | 4.25 |
| May 6 | 10.50 | 7.75 | 4.40 | 2.00 | 28 | 11.00 | 8.75 | 5.00 | 4.25 |
| 13 | 10.75 | 8.00 | 4.40 | 2.00 | Nov. 4 | 11.65 | 9.00 | 5.55 | 4.00 |
| 20 | 11.10 | 8.25 | 4.50 | 2.00 | 11 | 11.50 | 9.00 | 5.90 | 4.00 |
| 27 | 11.25 | 8.00 | 4.50 | 3.00 | 18 | 11.50 | 9.00 | 5.90 | 4.75 |
| June 3 | 11.25 | 8.25 | 4.50 | 3.10 | 25 | 11.75 | 9.25 | 6.00 | 4.50 |
| 10 | 11.25 | 8.25 | 4.75 | 3.10 | Dec. 2 | 11.75 | 9.25 | 6.50 | 4.00 |
| 17 | 11.25 | 8.25 | 4.75 | 3.10 | 9 | 11.75 | 9.25 | 6.10 | 4.10 |
| 24 | 11.25 | 8.40 | 4.00 | 3.00 | 16 | 12.00 | 9.25 | 6.10 | 4.40 |
| | | | | | 23 | 12.40 | 9.65 | 6.10 | 4.40 |
| | | | | | 30 | 12.40 | 9.65 | 6.10 | 4.40 |

[a] Waste Trade Journal, New York, Jan. 20, 1923.

## SECONDARY METALS RECOVERED.

The quantity of the metals contained in numerous alloys made partly or wholly from secondary material can not be definitely ascertained. The figures given as the result of the annual inquiry made by the Geological Survey are only approximate, but they constitute the sole available data on an important industry.

The increase in the value of the secondary metals, exclusive of gold, silver, platinum, iron, steel, and ferroalloys, recovered in the United States in 1922 was due to the much higher average price of tin, lead, and zinc and to the larger quantities of scrap metals.

The value of the secondary platinum, iridium, and palladium recovered in 1922 amounted to about $4,791,500, which was about 53 per cent of the value of the platinum and allied metals imported for consumption in the United States during the year.

The value of the gold or silver contained in old jewelry, dental waste, silver spoons, tableware, ornaments, and other articles remelted or refined in 1922 was $27,981,806. Mints and refineries reported the recovery of 6,623,568 fine ounces of silver and $23,484,403 in gold from waste or discarded material. Jewelry and dental waste furnish the largest supplies of secondary gold, and silverware and photographic waste of secondary silver. The recoveries of silver from waste film and from photographic solutions probably amounted to more than 1,000,000 ounces.

Most of the silver recovered from photographic waste is obtained from solutions and is recovered by the larger makers of films and plates and by the moving-picture industry. Generally these solu-

tions contain less than half an ounce of silver to the gallon. The recovery from waste film is probably 800 ounces to the million feet.[1]

It is difficult to estimate the value of ferrous scrap remelted in 1922. Estimates of the quantity vary from 6,000,000 to 7,500,000 long tons. A considerable part of the scrap ferrous metal contained nickel, tungsten, manganese, chromium, vanadium, molybdenum, or other alloys, which made it many times more valuable than the ordinary commercial iron and steel scrap, though the market is limited, and some knowledge regarding consumers is necessary to locate prospective purchasers. The railways are, on the whole, the largest producers of most kinds of metal scrap, as well as the largest users of new and remelted metal. It is estimated that the railways usually supply more than 40 per cent of the scrap iron and steel.

It is impracticable and unnecessary to segregate the statistics relating to the melting, refining, and use of secondary metals according to States. Nearly all the secondary aluminum was reported from Ohio, Michigan, Connecticut, Illinois, Wisconsin, and Missouri. The largest recoveries from tin dross, tin scruff, and clean tin scrap were made in Pennsylvania, New York, New Jersey, Illinois, and West Virginia. Nearly all the secondary nickel was reported from Connecticut, New York, Illinois, and New Jersey. The recoveries of lead, zinc, and copper and of such alloys as babbitt, bronze, brass, and pewter were more generally distributed, though the largest secondary smelters and refineries are in Pennsylvania, Illinois, Michigan, Ohio, New York, and New Jersey.

*Secondary metals of certain classes recovered in the United States in 1920, 1921, and 1922.*

| | 1920 | | 1921 | | 1922 | |
|---|---|---|---|---|---|---|
| | Short tons. | Value. | Short tons. | Value. | Short tons. | Value. |
| Copper, including that in alloys other than brass | 130,600 | $48,060,800 | 113,350 | $29,244,300 | 144,100 | $38,907,000 |
| Brass scrap remelted | 259,800 | 77,454,500 | 148,500 | 32,000,000 | 274,000 | 58,100,000 |
| Lead as metal | 56,350 | 19,944,000 | 46,370 | 9,340,200 | 75,480 | 17,551,600 |
| Lead in alloys | 68,300 | | 57,410 | | 84,080 | |
| Zinc as metal | 42,850 | 8,181,000 | 33,833 | 3,967,300 | 69,314 | 9,070,300 |
| Zinc in alloys other than brass and in chemical compounds | 7,650 | | 5,840 | | 10,250 | |
| Tin as metal | 7,200 | 22,705,700 | 5,400 | 9,668,500 | 6,570 | 12,443,500 |
| Tin in alloys | 16,300 | | 11,500 | | 12,940 | |
| Antimony as metal | 200 | 938,560 | 29 | 464,400 | 182 | 765,700 |
| Antimony in alloys | 5,400 | | 4,691 | | 6,908 | |
| Aluminum as metal | 5,000 | 9,489,100 | 3,650 | 3,775,400 | 7,190 | 6,085,900 |
| Aluminum in alloys | 10,500 | | 5,250 | | 9,100 | |
| Nickel as metal | 270 | 1,733,600 | 89 | 680,400 | 104 | 967,700 |
| Nickel in nonferrous alloys | 1,930 | | 859 | | 1,408 | |
| | ..... | 188,507,260 | ..... | 89,140,500 | ..... | 143,891,700 |

[1] Byers, C. A., Recovery of silver from movies' laboratory waste: Eng. and Min. Jour.-Press, Aug. 26, 1922, p. 373.

## SECONDARY COPPER.

*Secondary copper recovered in 1922.*

| | Short tons. |
|---|---|
| Copper as metal | 113,400 |
| Copper in alloys other than brass | 30,700 |
| | 144,100 |
| Copper from new scrap | 25,300 |
| Copper from old scrap | 118,800 |
| | 144,100 |
| Brass scrap remelted: | |
| New clean scrap | 154,000 |
| Old scrap | 120,000 |
| | 274,000 |
| Copper content of brass scrap (averaging 70 per cent copper): | |
| New scrap | 107,800 |
| Old scrap | 84,000 |
| | 191,800 |
| Total secondary copper: | |
| From new scrap | 133,100 |
| From old scrap | 202,800 |
| | 335,900 |
| Brass scrap imported | 71,962 |
| Scrap copper imported | 10,675 |
| Brass scrap exported | 3,147 |
| Scrap copper exported | 1,400 |

Of the total quantity of secondary copper recovered in 1922, 73,005 tons (19,762 tons more than in 1921) was recovered by plants refining primary metals and the remainder by plants treating only secondary materials. The copper produced by smelters of secondary material included 40,395 tons of pig copper, 30,700 tons of copper in alloys other than brass, and 191,800 tons of copper in remelted brass. These figures indicate a decrease of 5,382 tons in pig copper and increases of 16,370 tons in alloys other than brass and of 87,850 tons in brass.

The value of the copper, both as metal and in alloys, is computed at 13.5 cents a pound, the average price for the year of all marketable grades of new metal.

According to the Bureau of Foreign and Domestic Commerce the exports of scrap copper and brass in 1922 increased 1,270 tons and the imports 59,335 tons, or 255 per cent. Railways sell or turn in the larger portion of their brass and copper scrap and other metal waste to dealers in part payment for new material, but the reports show that the railways utilized in their own shops and foundries more than 10,000 tons of brass in addition to 1,000 tons of copper and 6,700 tons of copper in alloys other than brass. The railway reports, however, frequently include under "brass" alloys that should more properly be designated "bronze." On the other hand, manganese bronze should be called manganese brass,[2] and scrap metals can be successfully employed in making it.

[2] Livermore, F. A., Manganese bronze—the use of scrap; Brass World, February, 1923, pp. 43–44.

The names recommended by the American Society for Testing Materials to be used in connection with certain brass, bronze, and nickel alloys of copper are given in the report on secondary metals in Mineral Resources for 1919.

In the past large producers of certain virgin metals, particularly copper, zinc, and antimony, have paid too little attention to scrap metals; they have not realized that such metals as secondary copper and brass exert sufficient influence to affect the marketing and prices of new metals. The effect of the surplus quantity of scrap metals has, however, been significantly shown by the large purchases of cartridge cases and trimmings by manufacturers of brass rods sheets, and other products. The bulk of the domestic brass scrap has passed into consumers' hands or into the dealers' storage, so that most of the war scrap will cease to have any serious effect on the domestic scrap-metal market, though unexpectedly large quantities from Government sources were sold in 1922. In a recent article [3] an estimate is given of about 205,000 tons of copper contained in brass scrap available in Europe and the United States on January 1, 1921. Nearly all of this scrap was in Great Britain and France, and the shipments to the United States in 1922 were very much greater than in normal years.

## SECONDARY LEAD.

*Secondary lead recovered in 1922.*

| | Short tons. |
|---|---|
| Secondary lead recovered by smelters that treat mainly ores | 27,048 |
| Secondary lead recovered by smelters that treat only scrap and drosses | 48,432 |
| | 75,480 |
| Secondary lead recovered in remelted alloys: | |
| Lead content of antimonial lead scrap treated at regular lead smelters | 459 |
| Lead content of drosses and scrap alloys treated at secondary smelters | 83,621 |
| Total lead in alloys | 84,080 |
| Total secondary lead recovered | 159,560 |
| Refined primary lead produced in the United States: | |
| From domestic ores | 468,746 |
| From foreign ores and base bullion | 63,916 |
| Lead content of antimonial lead ores treated at regular smelters from foreign and domestic sources | 6,634 |

The secondary lead recovered in 1922 amounted to about 54 per cent more than in 1921. The secondary lead recovered as pig lead increased 29,110 tons, and the secondary pig lead recovered by those smelters whose product is mainly primary metal increased 12,249 tons. The quantity of secondary lead recovered in alloys increased 26,670 tons. A considerable part of the lead recovered from alloys was derived from old babbitt metal, solder, type metal, and white-metal drosses, but the main sources of secondary pig lead are old pipe, lead cable, battery plates, and lead lining of acid tanks. Regular primary smelters reported the recovery of 459 tons of lead in scrap antimonial lead, or 1,573 tons less than in 1921. About 21,680

[3] Kelley, C. F. (president of the Anaconda Copper Co.), Present and future of the copper industry; Metal Industry, Apr. 22, 1922.

short tons of antimonial lead in shrapnel was imported under the classification of type metal in 1922, a little more than in 1921.

The use of lead in batteries has expanded rapidly with the growth of the automotive industry, and a large part of the secondary lead now recovered is obtained from old batteries.

The total output of secondary lead was equal to about 30 per cent of the refined primary lead produced in the United States in 1922, compared with 23.1 per cent in 1921. It was exceeded by the output of primary domestic lead in only one State—Missouri.

## SECONDARY ZINC.

*Secondary zinc recovered in 1922.*

| | Short tons. |
|---|---|
| Secondary zinc recovered by redistillation | 32,988 |
| Secondary zinc recovered by sweating, remelting, etc | 36,326 |
| Total zinc recovered unalloyed | 69,314 |
| Zinc recovered in alloys other than brass | 10,250 |
| Zinc recovered in brass (estimated) | 60,280 |
| Zinc dust made from zinc dross | 3,783 |
| Zinc dross used for zinc dust | 4,414 |
| Zinc dross exported | 8,412 |
| Lithopone, made from zinc skimmings and ashes | 29,928 |

The output of secondary zinc (including that in brass) in 1922 was 39 per cent of the output of primary zinc in the United States, the same proportion as in 1921. The recovery was 61,544 tons more than in 1921, owing to the much larger quantity of zinc contained in brass and other alloys recovered and to the increase of 35,481 tons in the recoveries from scrap zinc, dross, and skimmings. The quantity of galvanized sheets and forms made in 1922 was 1,137,852 short tons, which was about 400,000 tons more than in 1921.

Four smelters—one each in New Jersey, New York, West Virginia, and Pennsylvania—treated zinc drosses and skimmings by means of large graphite retorts of 600 to 800 pounds capacity instead of the small clay retorts used by smelters treating ore or mixed ore and drosses. The many uses of zinc drosses and skimmings create active competition for their purchase. Considerable zinc is recovered by sweating, and the residues are then sold for redistillation.

The production of zinc from drosses and skimmings made by smelters by redistillation was 15,415 tons more in 1922 than in 1921.

The zinc recovered in alloys other than brass amounted to 10,250 tons, compared with 5,840 tons in 1921. Of the secondary zinc recovered unalloyed slightly less than half was obtained by redistillation from drosses and skimmings and the remainder by sweating and remelting. In addition to the 69,314 tons of remelted and redistilled zinc, 29,928 tons out of a total production of 82,515 tons of the zinc pigment lithopone (containing approximately 30 per cent sulphide and oxide) was made from zinc skimmings and ashes. It is estimated that the zinc content of skimmings and ashes used for lithopone was 6,095 tons. The quantity of zinc chloride made in 1922 was 48,370 short tons, of which 37,885 tons, containing 8,334 tons of zinc, was made from zinc ashes and skimmings. The secondary zinc recovered in all zinc pigments in 1922, including that in lithopone, was 8,609 short tons, and that recovered in zinc sulphate 682 short tons. The exports of zinc drosses, which amounted to

5,123 tons in 1919, 2,445 tons in 1920, and 510 tons in 1921, increased to 8,412 tons in 1922. The zinc recovered in brass increased from about 38,627 tons in 1921 to 60,280 tons in 1922.

Two plants in San Francisco are making zinc dust from zinc dross, so that all that material available on the Pacific coast has a good market; but none of the secondary plants on the Pacific coast treat zinc ashes or skimmings, and it is necessary to ship them to eastern plants for treatment. About 4,400 tons of dross was used to make 3,783 tons of zinc dust.

## SECONDARY ANTIMONY.

The production of secondary antimony in 1922, of which all but 182 tons was recovered in alloys, amounted to 7,090 tons, an increase of about 50 per cent. The value given in the table on page 182 is based on the average yearly price for ordinary brands of antimony as published by the American Metal Market. The regular smelters reported the recovery of 81 tons of antimony contained in 540 tons of antimonial lead scrap. The recovery from secondary sources was equal to about 70 per cent of the imports, which were unusually small. The principal materials refined or resmelted that contained antimony as an alloy were hard-lead drosses, babbitt, battery plates, solder, pewter, and type metal. Antimony used in the rubber, glass, enamel, paint, and ceramic industries does not yield any secondary recoveries. The quantity of antimony used for coloring rubber and for pigments has materially increased in the last four years.

No production of antimony from domestic antimony ore was reported in 1922. There was 8,075 short tons of primary antimonial lead, which contained 1,441 tons of antimony, recovered at the smelters. The antimony imported as metal or as oxide or salts amounted to 10,412 tons.

## SECONDARY TIN.

*Secondary tin recovered in 1922, with imports.*

| | | |
|---|---|---|
| Tin recovered as pig tin | short tons | 6,570 |
| Tin recovered in alloys and chemical compounds | do | 12,940 |
| | | 19,510 |
| Clean tin-plate scrap treated | long tons | 134,275 |
| Old tin-coated containers treated | do | 407 |
| Metallic tin recovered at detinning plants | pounds | 1,445,780 |
| Tin content of tin tetrachloride, tin bichloride, and tin oxide made at detinning plants | pounds | 3,405,400 |
| Total tin recovered at detinning plants | do | 4,851,180 |
| Tin tetrachloride, tin bichloride, and tin oxide made at detinning plants | pounds | 7,008,500 |
| Average quantity of tin recovered per long ton of old tin-coated containers | pounds | 22.4 |
| Average quantity of tin recovered per long ton of clean tin-plate scrap | pounds | 36.06 |
| Tin imported as metal for consumption in 1922 | short tons | 67,416 |
| Tin concentrates imported for consumption in 1922 | do | 13,835 |
| Tin produced from foreign concentrates smelted in the United States | short tons | 9,108 |
| Percentage of secondary tin recovered to tin imported as metal or smelted from foreign ores imported | | 25 |

Although the United States consumes more than 50 per cent of the world's output of tin, apparently no metallic tin was derived from domestic mines in 1922.

The secondary tin recovered increased from 16,900 tons, valued at $9,668,500, in 1921 to 19,510 tons, valued at $12,443,500, in 1922, equal to about 25 per cent of the tin imported as pig metal or smelted from foreign concentrates in the United States during the year (76,524 short tons). The value of the recovered tin here assigned is arbitrary and is based on the yearly average prices (31.89 cents) for 99 per cent metal, with prompt delivery at New York, given by the American Metal Market. The secondary tin in alloys increased 1,440 tons, and the secondary pig tin increased 1,170 tons.

Nearly all clean tin-plate scrap is detinned by one of three processes—the electrolytic alkali, the chlorine, or the alkali saltpeter.[4]

The tin reported recovered in alloys and compounds included the tin content of products made in several plants from clean tin-plate scrap and old tin-coated cans. The materials recovered included some tin oxide and putty powder but consisted mainly of tin tetrachloride and tin bichloride. The production of these compounds is stated together, in order to avoid disclosing confidential information. As the products are made from scrap tin and thus conserve the primary metal, they are properly regarded as recovered tin.

The largest recoveries of tin were made from the scruff and drosses that occur in making tin plate and terneplate and amounted to about 6,000 tons. The quantity of tin plate and terneplate made in 1922 was 1,287,700 long tons, or 494,500 long tons more than in 1921.

About 2,421 short tons of tin was recovered from clean scrap tin plate, either as pig tin or as tin chloride or tin oxide. Apparently only about 300 tons of pig tin was recovered from scrap tin (not tin plate), clippings, old tin pipe, tin foil, and collapsible tubes, and it is impossible to give separately the quantities of tin recovered from these sources. Old block-tin pipe is most acceptable scrap, but the quantity available is small and is steadily declining. A considerable quantity of tin was also recovered from waste tin liquors used in dyeing.

Nearly all the tin-plate scrap imported in 1922 came from Canada.

Tin-coated scrap and old cans are frequently utilized in western mining regions for their iron content in the precipitation of copper from mine waters; the tin coating, however, is wasted. A comparatively small quantity of old tin containers was used to make sash weights by remelting in a cupola. The impure metal recovered is not suitable for castings, being too brittle. An investigation conducted by the Bureau of Mines showed that in an electric furnace detinning the scrap was impracticable, though synthetic cast iron made from tin-plate scrap was used successfully in making castings of good quality. A small portion of the clean tin strips cut from sheets is sold to makers of boxes and baskets and is used to bind, strengthen, or fasten the tops of the containers made. The Metal & Thermit Co.'s plant at San Francisco treated scrap tin plate, which formerly was shipped to eastern plants.

A large quantity of tin was recovered in bronze, and part of the brass remelted contains a little tin and lead, which in the aggregate

[4] A short history of the detinning industry: Met. and Chem. Eng., August, 1917, pp. 187–189.

amounts to a considerable quantity. Other alloys from which secondary tin was recovered were solder, babbitt, pewter, terne metal, and electrotype metal.

From reports received by the Geological Survey the clean tin-plate scrap detinned in 1922 was about 30,200 long tons more than in 1921. The average metallic content of the tin oxide was given as 78.9 per cent, that of the tin bichloride as 24.5 per cent, and that of the tin tetrachloride between 45.4 and 46 per cent.

The relatively small quantity of secondary tin recovered from tin-plate scrap and old tin-coated cans is significantly shown when compared with the quantity of tin used in making tin plate. It is estimated that 28,000 short tons of tin was used by makers of tin plate in 1922, that the total recovery of tin as metal and in compounds from tin-plate scrap and old cans was 2,426 short tons, and that of this quantity only about 5 tons was obtained from old cans.

All the old cans detinned in 1922 were treated by the Vulcan Detinning Co. The cans purchased were classified as follows:

Class 1. Unused empty and unrusted tin cans not exceeding the 1-gallon size, with or without labels attached but otherwise free from foreign material such as ice, water, ashes, paint, varnish, white lead, and similar insoluble (in water) contents.

Class 2. Used cans not exceeding the 1-gallon size and otherwise as described in class 1.

Class 3. Used empty and unrusted tin cans exceeding in size the 1-gallon size but not exceeding the 5-gallon size and otherwise as described in class 1.

A description of the method used in treating old tin-coated cans is given in this report for 1919.

New tin-plate clippings were treated at plants of the Vulcan Detinning Co. at Sewaren, N. J., Neville Island, Pa., and Streator, Ill.; by the Johnson & Jennings Co., of Cleveland, Ohio; and at the plants of the Metal & Thermit Co. at San Francisco, East Chicago, Ind., and Chrome, N. J.

The plants utilizing old tin cans, which can handle 25,000 tons a year, treated only 407 long tons in 1922. These plants have never received shipments large enough to operate steadily at full capacity, even when the prices of tin and black sheet-metal scrap were high. The detinning companies have reduced the price paid for old cans to about $3 or $4 a long ton. The present prices do not warrant even local collections of old cans, and the plants are practically idle. The supply of tin chloride, which is made almost entirely from scrap and which is the main product of detinning plants, is ample since war uses have ceased.

Although there is now a supply of tin sufficient for all requirements at less than pre-war prices, there are two good reasons for restricting its use to the lowest point. One is that the supply of new tin is derived almost entirely from foreign sources, and the other is that tin is a relatively high-priced metal and the use of substitutes giving approximately equal efficiency radically reduces the cost of many alloys, such as solder, babbitt, and other bearing metals.

## SECONDARY ALUMINUM.

*Secondary aluminum recovered in 1922, with imports, exports, and domestic production of primary aluminum.*

| | | |
|---|---|---|
| Secondary aluminum recovered | short tons | 7,190 |
| Aluminum recovered in alloys (mainly No. 12) | do | 9,100 |
| | | 16,290 |
| Value of primary aluminum produced in the United States in 1922 | | $13,622,000 |
| Aluminum (crude and semicrude) imported for consumption | pounds | 43,892,588 |
| Aluminum exported as pig aluminum, plates, sheets, and alloys | pounds | 4,347,020 |

The recovery of secondary aluminum as pig aluminum or in alloys in 1922 amounted to 16,290 short tons, valued at $6,085,900, compared with 8,900 tons, valued at $3,775,400, in 1921.

Some of the larger secondary smelters and refiners of aluminum in 1922 were as follows:

Peninsular Smelting Co., Detroit, Mich.
Michigan Smelting & Refining Co., Detroit, Mich.
United Smelting & Aluminum Co., New Haven, Conn.
United States Reduction Co., East Chicago, Ind.
United States Aluminum Co., Niagara Falls, N. Y.
Great Western Smelting & Refining Co., St. Louis, Mo.
Cleveland Electro Metals Co., Cleveland, Ohio.
Loewenthal Co., Chicago, Ill.
National Smelting Corporation, Cleveland, Ohio.
Charles L. Hilb Smelting & Refining Co., Cincinnati, Ohio.
Columbia Smelting & Refining Co., New York, N. Y.
W. F. Jobbins Co. (Inc.), Aurora, Ill.

Various products are made by smelters and refiners from scrap aluminum.

A large quantity of No. 12 secondary ingots (92 per cent aluminum and about 8 per cent copper) is made by smelters from old or defective castings, borings, and scrap, as is shown by the fact that the secondary recovery of aluminum in alloys was nearly 56 per cent of the total recovery in 1922. The expanded output of the automotive industry, which is estimated to consume 22 per cent of the aluminum production, is reflected in the increased consumption of secondary No. 12 alloy. The recovery of aluminum in alloys in 1922 was 73 per cent more than that reported in 1921. The recent articles relating to aluminum are as follows:

Anderson, R. J., Iron-pot melting practice for aluminum alloys: Metal Industry, February, 1922, p. 60.

German practice in melting aluminum scrap: Min. Jour. (London), Aug. 6, 1921, p. 591.

Notes on aluminum alloys for casting, prepared by the technical department, Aluminum Co. of America: Chem. and Met. Eng., Sept. 6, 1922, p. 501.

The following articles on aluminum were published in the report for 1919 on secondary metals:

Casting losses in aluminum foundry practice in the United States, by Robert J. Anderson.
Scrap aluminum, by Charles Vickers.
Tentative specifications for aluminum presented to the American Society for Testing Materials

## SECONDARY NICKEL.

*Secondary nickel recovered in 1922, with imports, exports, and domestic production of primary nickel.*

| | Short tons. |
|---|---|
| Nickel recovered as metal | 104 |
| Nickel recovered in nonferrous alloys and salts | 1,408 |
| | 1,512 |
| Nickel produced as a by-product from the electrolytic refining of copper at domestic refineries | 208 |
| Nickel imported for consumption in the United States as nickel or in nickel ores and matte, oxide, and alloys | 7,460 |
| Nickel, nickel oxide, and matte exported | 4,659 |

The nickel recovered from secondary sources in 1922 includes nickel in monel metal but not that in ferrous alloys. Most of the nickel in matte, oxide, ore, etc., imported came from the Sudbury district, Ontario. The nickel-copper matte imported is partly refined and partly smelted to make monel metal.[5] No nickel was recovered at the refinery of the Missouri Cobalt Co., at Fredericktown, Mo., from ores that contain nickel, lead, copper, and cobalt, and the only production from domestic sources was obtained from the electrolytic refining of copper.

Formerly about 60 per cent of the refined nickel produced was used in nickel steel, 30 per cent in white-metal alloys, 5 per cent in anodes for plating, and 5 per cent for miscellaneous purposes, including the manufacture of salts and other chemical compounds. Since the World War, however, much less nickel is used in ferrous alloys, and the percentages stated do not apply to present conditions. New uses are being developed to use the nickel formerly used for war purposes.

As nickel is used chiefly as an alloy in steel, and as the secondary nickel reported to the Geological Survey as recovered in 1922 was obtained solely from nonferrous scrap, it is evident that the 1,512 tons of nickel reported forms only a portion of the nickel in alloys recovered and reused, though that portion was much larger in 1922 than in any of the years 1914 to 1920. The nickel imported for consumption in 1921 was only about 29 per cent of the imports in 1922. The secondary metal recovered from nonferrous sources in 1922 was equal to about 20 per cent of the imports, whereas in 1920 it amounted to only 9 per cent.

The secondary nickel reported in 1922 was nearly all recovered from old nickel anodes, nichrome, nickel silver, and monel metal. A nickel alloy which is now being more generally used is composed of about 60 per cent nickel and the remainder mainly chromium. The properties and uses of this alloy, called "nichrome," are described in an article recently published.[6] Extracts from this article are given in the report on secondary metals in 1919.

Analyses of various nickel alloys have already been published by the United States Geological Survey.[7]

The International Nickel Co., desiring to assist users of monel metal to dispose of scrap and at the same time to protect the purity of

[5] Bregman, Adolph, Methods of melting and casting, uses, etc., of monel metal: Metal Industry, vol. 19, pt. 1, pp. 9–10; pt. 2, pp. 64–65.
[6] Equipment for foundry and plating room: Brass World, vol. 16, pp. 146–147, May, 1920.
[7] Hess, F. L., Nickel: U. S. Geol. Survey Mineral Resources, 1915, pt. 1, pp. 763–765, 1917.

the primary metal, has established a definite procedure in the purchase of monel scrap ("Inco"). The company's publication contains the following information:

The mining and smelting operations are located at Copper Cliff, Ontario; the refining and rolling operations are located at Port Colborne, Ontario, and Huntington, W. Va. Monel-metal scrap must enter operations at one of these points. This is decided to a large extent by the purity of the scrap.

Monel metal as produced is held to a close chemical specification. It contains approximately 67 per cent of nickel, 28 per cent of copper, and 5 per cent of other elements. It has in it no lead and no zinc.

If the user has not allowed other materials to become mixed with his scrap it should meet production specifications. However, it is not entirely possible to prevent all contamination, and in the purchase of scrap the International Nickel Co. allows a certain tolerance. Therefore, scrap within the analysis given below will be purchased at a flat price, which will be quoted on receipt of detailed description of the scrap offered from time to time by the consumer.

Nickel, not less than 64 per cent; copper, not less than 27 per cent; iron, not more than 3½ per cent; sulphur, not more than 0.05 per cent; lead, none; zinc, none.

Providing such scrap does not come within the above analysis, settlement will be made on a basis of copper-nickel content, the price of which will be quoted after sampling and analysis by the International Nickel Co. All scrap will be purchased and settled for on a basis of weight, sample, and analysis.

The cost of sampling and analyzing a shipment of scrap is approximately $35. It is therefore necessary to avoid handling small shipments of scrap, if possible, and all consumers are requested to collect their scrap until they have at least 500 pounds before offering it for sale.

# GOLD, SILVER, AND LEAD IN SOUTH DAKOTA.

(MINES REPORT.)

By C. W. Henderson.

## PRODUCTION.

Of the six producing mines in South Dakota in 1922 three were deep and three were small placers—a decrease of three placers from 1921 but the same number of deep mines. The mills of the State treated 1,751,454 tons of ore, which yielded as bullion $6,515,969 in gold and 118,753 fine ounces of silver, valued at $118,753, an average recovery per ton of $3.720 in gold and 0.0678 ounce in silver, as compared with $3.826 in gold and 0.065 ounce in silver in 1921.

*Mine production of gold, silver, and lead in South Dakota in 1921 and 1922.*

| Year. | Number of producing mines. | Ore (short tons). | Gold.[a] | | Silver.[a] | | Lead. | | Total value. |
|---|---|---|---|---|---|---|---|---|---|
| | | | Fine ounces. | Value. | Fine ounces. | Value. | Pounds. | Value. | |
| 1921 | 9 | 1,725,685 | 319,524.95 | $6,605,167 | 112,464 | $112,464 | 4,000 | $180 | $6,717,811 |
| 1922 | 6 | 1,751,454 | 315,297.99 | 6,517,788 | 118,760 | 118,760 | ..... | ..... | 6,636,548 |
| Increase or decrease, 1922 | −3 | +25,769 | −4,226.96 | −87,379 | +6,296 | +6,296 | −4,000 | −180 | −81,263 |

[a] Includes placer production.

*Gold and silver bullion produced at mills in South Dakota in 1922.*

| Process. | Ore treated. | Gold in bullion. | Silver in bullion. | Quicksilver used. | Sodium cyanide used. |
|---|---|---|---|---|---|
| | *Short tons.* | *Fine ounces.* | *Fine ounces.* | *Pounds.* | *Pounds.* |
| Amalgamation | 1,663,525 | 218,247.50 | 58,806 | 7,500 | ..... |
| Cyanidation | [a] 1,708,628 | 96,962.50 | 59,947 | ..... | [b] 387,683 |
| | ..... | 315,210.00 | 118,753 | 7,500 | [b] 387,683 |

[a] Includes 1,620,699 tons of sands and slimes from the ore amalgamated and 87,929 tons of ore cyanided.
[b] Equivalent to 96–98 per cent NaCN.

*Mine production of gold and silver in South Dakota, 1876–1922.*[a]

| Period. | Gold. | Silver. | | Total value (commercial). |
|---|---|---|---|---|
| | | Fine ounces. | Commercial value. | |
| 1876–1880 | $11,255,843 | 80,292 | $92,452 | $11,348,295 |
| 1881–1890 | 30,800,000 | 1,472,580 | 1,515,224 | 32,315,224 |
| 1891–1900 | 48,005,555 | 1,729,873 | 1,155,691 | 49,161,246 |
| 1901–1910 | 65,242,.96 | 1,790,365 | 1,013,349 | 66,255,545 |
| 1911 | 7,439,874 | 203,755 | 107,990 | 7,547,864 |
| 1912 | 7,891,370 | 206,460 | 126,973 | 8,018,343 |
| 1913 | 7,319,294 | 172,702 | 104,312 | 7,423,606 |
| 1914 | 7,333,508 | 176,642 | 97,683 | 7,431,191 |
| 1915 | 7,406,305 | 199,864 | 101,331 | 7,507,636 |
| 1916 | 7,460,644 | 215,205 | 141,605 | 7,602,249 |
| 1917 | 7,364,233 | 186,765 | 153,894 | 7,518,127 |
| 1918 | 6,565,337 | 159,202 | 159,202 | 6,724,539 |
| 1919 | 4,863,040 | 116,493 | 130,472 | 4,993,512 |
| 1920 | 4,676,470 | 90,795 | 98,966 | 4,775,436 |
| 1921 | 6,605,167 | 112,464 | 112,464 | 6,717,631 |
| 1922 | 6,517,788 | 118,760 | 118,760 | 6,636,548 |
| | 236,746,624 | 7,032,217 | 5,230,368 | 241,976,992 |

[a] For yearly output to 1913 and authority for each year, see U. S. Geol. Survey Mineral Resources, 1913, pt. 1, p. 42, 1914.

*Mine production of gold and silver in South Dakota in 1922, by classes of ore.*

| Source. | Number of mines. | Ore. | Gold. | Silver. |
|---|---|---|---|---|
| | | *Short tons.* | *Fine ounces.* | *Fine ounces.* |
| Deep mines (dry gold ore) | 3 | 1,751,454 | 315,210.00 | 118,753 |
| Placer mines | 3 | ..... | 87.99 | 7 |
| | 6 | 1,751,454 | 315,297.99 | 118,760 |

## MINING INDUSTRY.

Production was continuous in 1922 at the Homestake mine, from which the bulk of the production of South Dakota has come since 1875. The Trojan mill was operated continuously but not at capacity. Minor operations are noted in the review by counties.

## REVIEW BY COUNTIES.

### CUSTER COUNTY.

A very small quantity of placer gold was produced near Custer, Custer County, in 1922 but did not reach a market before 1923, and data as to the exact number of ounces and fineness were unavailable for the 1922 report. The Spokane property, opened by a 230-foot inclined shaft, was unwatered for inspection.

## LAWRENCE COUNTY.[a]

*Mine production of gold, silver, copper, and lead in Lawrence County, S. Dak., 1916–1922.*

| Year. | Number of mines producing. | Ore. | Gold.[b] | Silver.[b] | Copper. | Lead. | Total value. |
|---|---|---|---|---|---|---|---|
| | | *Short tons.* | | *Fine ounces.* | *Pounds.* | *Pounds.* | |
| 1916 | 29 | 1,870,572 | $7,455,136 | 215,127 | ..... | 35,406 | $7,599,127 |
| 1917 | 24 | 1,868,143 | 7,360,266 | 186,436 | 736 | 60,905 | 7,519,328 |
| 1918 | 13 | 1,781,661 | 6,564,850 | 158,108 | 2,996 | 11,536 | 6,724,517 |
| 1919 | 5 | 1,329,928 | 4,863,013 | 116,010 | ..... | 6,585 | 4,993,293 |
| 1920 | 7 | 1,356,189 | 4,676,470 | 90,795 | ..... | 12,812 | 4,776,461 |
| 1921 | 3 | 1,725,685 | 6,603,318 | 112,457 | ..... | 4,000 | 6,715,955 |
| 1922 | 4 | 1,751,414 | 6,515,969 | 118,753 | ..... | ..... | 6,634,722 |
| Increase or decrease, 1922 | +1 | +25,729 | −87,349 | +6,296 | ..... | −4,000 | −81,233 |

[a] For information on the geology of this county, see Irving, J. D., Ore deposits of the northern Black Hills: U. S. Geol. Survey Bull. 225, pp. 123–140, 1904; Irving, J. D., and Emmons, S. F., Economic resources of the northern Black Hills: U. S. Geol. Survey Prof. Paper 26, pp. 53–212, 1904.

[b] Includes both placer and deep mines.

The total value of the product of the Homestake Mining Co. from 1875 to 1922 is $182,019,257.43, and the amount paid in dividends is $43,803,724.29.

*Production of Homestake mine, 1916–1922.*

| Year. | Ore milled. | Value of product. | | Dividends. |
|---|---|---|---|---|
| | | Total. | Per ton. | |
| | *Short tons.* | | | |
| 1916 | 1,600,220 | $6,531,003.34 | $4.0813 | $2,210,208.00 |
| 1917 | 1,677,623 | 6,619,573.94 | 3.9458 | 1,959,048.00 |
| 1918 | 1,628,630 | 5,916,890.31 | 3.6330 | 1,506,960.00 |
| 1919 | 1,192,588 | 4,346,115.79 | 3.6443 | 1,130,220.00 |
| 1920 | 1,274,944 | 4,410,193.73 | 3.4591 | ..... |
| 1921 | 1,620,588 | 6,299,780.38 | 3.8873 | 502,320.00 |
| 1922 | 1,663,485 | 6,285,317.56 | 3.7784 | 879,060.00 |

The annual report of the superintendent of the Homestake Mining Co., dated December 31, 1922, says:

I am pleased to report another year of successful operation at the Homestake mine. Production has been continuous throughout the year. The South mill was completed and put into service. The Homestake mill was shut down on November 18, 1922. The Ellison electric hoist and crushing equipment have been tried out and are now in working order. Additional compressors for both haulage and air drills have been purchased and are now being erected. The addition to the hospital, which was started during the year, will be completed during the early part of 1923. The mine is in good condition for the continuous production of ore. The mine engineers report as follows: Development drifts driven 4,019 feet; development raises driven 3,261 feet. Ellison shaft sunk 100 feet, the bottom of the shaft now being 69 feet below the 2,300-foot level. There are 1,137,059 tons of ore broken down and remaining in the stopes.

The Homestake mine[1] is developed by four vertical shafts from 800 to 2,370 feet deep and 62 miles of tunnels, drifts, and crosscuts. The mills, situated at Lead, Terraville, Blacktail, and Deadwood, have a total capacity of 4,600 tons a day and consist of six primary

[1] For description of geology, see Paige, Sidney, The geology of the Homestake mine; Econ. Geology, vol. 18, pp. 205–237, 1923; Hosted, J. O., and Wright, L. B., Geology of the Homestake ore bodies and the Lead area, S. Dak.: Eng. and Min. Jour.-Press. May 5, 1923, pp. 793–799, and May 12, 1923, pp. 836–843.

mills, the Amicus, Golden Star, Pocahontas, Monroe, South, and Terraville, and four secondary mills, including a regrinding mill, two cyanide sand plants, and one slime plant. The crushing equipment includes 700 stamps weighing 900 pounds each and 120 weighing 1,550 pounds each, and the area of amalgamating plates amounts to 30,000 square feet. There are six Allis-Chalmers rod mills, six Allis-Chalmers and one Hardinge tube mills, and one Hardinge ball mill, also 26 leaching tanks and 47 thickening tanks.

The Trojan 400-ton cyanidation mill was operated continuously during the year but not at capacity. The ore is siliceous and oxidized and is reached by two shafts 308 and 568 feet deep, eight tunnels aggregating 17,700 feet, and 40,400 feet of drifts. The ore is brought to the mill by a surface tramway three-fourths of a mile long. The mill is equipped with one No. 5 K Gates crusher, two ball mills, one Chile mill, four Dorr classifiers, one Weigand classifier, three Portland filters, six leaching tanks, five Dorr agitating tanks, and five Dorr thickening tanks. A small quantity of gold bullion was recovered in a clean-up of the dismantled Golden Reward cyanidation mill. The Gold Feather Co. built a 100-ton mill in 1922 on the Monarch property, in Two Bit Gulch. The mill is equipped with a Blake crusher, an Allis-Chalmers rod mill, and amalgamating plates. No ore was milled in 1922, but early in 1923 a test run of two weeks was made.

Several small lots of placer gold were recovered by panning and sluicing near Tinton.

### PENNINGTON COUNTY.

Drifting and sluicing operations on the Hudo claim, 2½ miles west of Mystic, on Castle Creek, from which a considerable quantity of placer gold was recovered from August to December, 1921, were continued in 1922, with production.

In the course of prospecting and development work on the Doctor No. 2 claim, near Redfern, a small quantity of gold ore was milled in a 1-stamp mill with a Nelson concentrator, from which was recovered by amalgamation and panning several ounces of gold bullion.

# GOLD, SILVER, AND COPPER IN WYOMING.

(MINES REPORT.)

By Charles W. Henderson.

## PRODUCTION.

One car of copper-gold-silver ore from the Electrolytic (Rambler) mine, near Albany, constituted the marketed output of ores mined in Wyoming in 1922. There was, however, a small revival in placer mining in Crook, Fremont, and Park counties.

*Mine production of gold, silver, and copper in Wyoming, 1842–1922.*[a]

| Period. | Ore (short tons). | Gold. | Silver. | | Copper. | | Total value. |
|---|---|---|---|---|---|---|---|
| | | | Fine ounces. | Commercial value. | Pounds. | Value. | |
| 1842–1866 | | (b) | | | | | |
| 1867–1870 | | $396,100 | 3,170 | $4,098 | | | $400,198 |
| 1871–1880 | | 400,000 | 3,240 | 4,115 | | | 404,115 |
| 1881–1890 | | 67,500 | 2,940 | 3,126 | 1,395,287 | $230,521 | 301,147 |
| 1891–1900 | | 131,700 | 1,400 | 943 | 7,541,647 | 1,257,649 | 1,390,292 |
| 1901–1910 | | 130,259 | 45,983 | 26,896 | 16,906,466 | 2,579,095 | 2,736,250 |
| 1911 | 3,491 | 19,200 | 725 | 384 | 130,499 | 16,312 | 35,896 |
| 1912 | 2,439 | 22,235 | 265 | 163 | 25,080 | 4,138 | 26,536 |
| 1913 | 4,236 | 24,184 | 957 | 578 | 385,239 | 59,712 | 84,474 |
| 1914 | 423 | 5,006 | 116 | 64 | 17,421 | 2,317 | 7,387 |
| 1915 | 4,216 | 14,592 | 840 | 426 | 447,246 | 78,268 | 93,286 |
| 1916 | 8,876 | 20,566 | 5,524 | 3,635 | 2,610,622 | 642,213 | 666,414 |
| 1917 | 6,335 | 3,762 | 3,415 | 2,814 | 2,027,857 | 553,605 | 560,181 |
| 1918 | 2,870 | 871 | 965 | 965 | 852,777 | 210,636 | 212,472 |
| 1919 | 798 | 84 | 151 | 169 | 139,900 | 26,021 | 26,274 |
| 1920 | | | | | | | |
| 1921 | 50 | 62 | 111 | 111 | 10,000 | 1,290 | 1,463 |
| 1922 | 24 | 1,207 | 57 | 57 | 4,296 | 580 | 1,844 |
| | | 1,237,328 | 69,859 | 48,544 | 32,494,337 | 5,662,357 | 6,948,229 |

[a] For yearly output, 1842–1914, see U. S. Geol. Survey Mineral Resources, 1914, pt. 1, pp. 248–249, 1916.
[b] Small; unknown.

## REVIEW BY COUNTIES.

*Albany County.*—From the Electrolytic mine (long known as the Rambler), at Holmes, one car of copper ore, carrying also gold, silver, platinum, and palladium, was shipped to an eastern refinery, which made at least a partial settlement for the rare-metal content in addition to the other metals. The Iron Blossom Mining Co., at Holmes, according to its statement for the year ending August 14, 1922, showed an expenditure of $20,611 in wages, material, purchase of land and expenses in patenting, and other expenses, for which

assets are given as 295.3 acres of patented and deeded lands and 138 acres held under State laws. The report states that the State of Wyoming has granted 10.8 second-feet of water for developing power out of the South Fork of Little Laramie River and Slide Gulch, a tributary.

*Crook County.*—Stripping and drifting followed by panning and sluicing in Willow Creek, across the line from Tinton, S. Dak., recovered a small quantity of placer gold nuggets, which were sold to tourists.

*Fremont County.*—Sluicing and panning in Mary Ellen Gulch, Rock Creek, and Big Atlantic Gulch, near Atlantic City, resulted in the recovery of some placer gold, averaging 0.809 in gold fineness and 0.127½ in silver fineness. Assessment work was done at the Duncan-Mary Ellen group in connection with an examination of the property and the district.

*Park County.*—Several sluicing operations in the gravel bed of Clark Fork of Yellowstone River resulted in the recovery of small quantities of fine placer gold averaging 0.923 in gold fineness and 0.076 in silver fineness.

*Platte County.*—No copper ore was shipped from the Sunrise iron mine, at Hartville, although shipments of iron ore to Pueblo, Colo. were resumed.

# GOLD, SILVER, COPPER, LEAD, AND ZINC IN NEW MEXICO.[1]

(MINES REPORT.)

By Charles W. Henderson.

## PRODUCTION.

The total calculated gross value of the gold, silver, copper, lead, and zinc produced in New Mexico from ore and gravel in 1922 increased more than 122 per cent over the value in 1921. There were 91 producing mines, of which 74 were deep and 17 placers, an increase of 34 deep mines and 8 placers.

*Mine production of gold, silver, copper, lead, and zinc in New Mexico, 1904–1922.*

| Year. | Ore. | Gold.[a] | Silver.[a] | Copper. | Lead. | Zinc. | Total value. |
|---|---|---|---|---|---|---|---|
| | *Short tons.* | | *Fine ounces.* | *Pounds.* | *Pounds.* | *Pounds.* | |
| 1904 | 102,339 | $381,930 | 214,553 | 4,972,170 | 3,122,872 | 13,493,835 | $1,961,390 |
| 1905 | 145,629 | 317,510 | 369,192 | 6,126,025 | 1,510,209 | 15,142,254 | 2,460,535 |
| 1906 | 207,691 | 293,019 | 491,127 | 7,028,670 | 2,987,369 | 17,292,655 | 3,203,739 |
| 1907 | 219,992 | 329,982 | 705,544 | 10,990,015 | 3,809,881 | 750,085 | 3,239,823 |
| 1908 | 135,434 | 298,757 | 405,044 | 6,112,630 | 873,763 | 3,576,516 | 1,525,091 |
| 1909 | 164,156 | 239,491 | 397,783 | 5,393,146 | 5,029,767 | 13,085,945 | 2,070,368 |
| 1910 | 191,865 | 482,424 | 843,987 | 4,614,386 | 4,320,841 | 18,088,129 | 2,691,080 |
| 1911 | 232,699 | 762,808 | 1,354,540 | 4,057,040 | 2,966,222 | 10,237,176 | 2,704,843 |
| 1912 | 1,352,286 | 784,446 | 1,536,701 | 34,030,964 | 5,494,018 | 13,566,637 | 8,527,955 |
| 1913 | 2,217,660 | 881,926 | 1,631,273 | 56,308,706 | 3,946,304 | 16,523,161 | 11,694,002 |
| 1914 | 2,232,853 | 1,171,696 | 1,777,445 | 59,307,925 | 1,763,641 | 18,403,392 | 11,049,932 |
| 1915 | 2,797,072 | 1,461,105 | 2,005,531 | 76,788,366 | 4,542,361 | 25,404,064 | 19,279,468 |
| 1916 | 3,870,950 | 1,382,480 | 1,766,274 | 92,747,289 | 8,214,189 | 36,570,649 | 30,827,767 |
| 1917 | 4,576,827 | 1,064,158 | 1,394,365 | 105,568,000 | 9,108,804 | 30,200,000 | 34,896,936 |
| 1918 | 4,749,784 | 682,791 | 782,421 | 98,264,563 | 8,398,239 | 24,050,324 | 28,521,413 |
| 1919 | 2,155,998 | 655,656 | 837,418 | 51,150,541 | 2,886,513 | 7,594,644 | 11,814,958 |
| 1920 | 2,250,718 | 480,302 | 768,042 | 54,400,691 | 2,869,525 | 10,013,580 | 12,367,857 |
| 1921 | 611,576 | 196,822 | 571,899 | 14,267,338 | 678,601 | 228,000 | 2,651,145 |
| 1922 | 1,576,920 | 412,693 | 752,240 | 31,937,207 | 3,012,223 | 4,496,806 | 5,898,446 |
| Increase, 1922 | 965,344 | 215,871 | 180,341 | 17,669,869 | 2,333,622 | 4,268,806 | 3,247,301 |

[a] Includes placer production.

### ORE.

The bullion derived from 54,512 tons of ore treated in 1922 at amalgamating and cyaniding mills in New Mexico contained $217,594 in gold, or $3.99 a ton, and 262,663 ounces of silver, valued at $262,663, or 4.82 ounces to the ton. The bullion recovered per ton of ore treated in 1921 was $2.41 in gold and 4.86 ounces in silver.

### GOLD.

The gold recoverable from ore and gravel mined in New Mexico in 1922 amounted to 19,964.02 fine ounces, valued at $412,693. Catron County produced 34 per cent of the total, Hidalgo County

[1] For reports on geology and description of mines, see Lindgren, Waldemar, Graton, L. C., and Gordon, C. H., The ore deposits of New Mexico: U. S. Geol. Survey Prof. Paper 68, 1910; also Finlay, J. R., Report of appraisal of mining properties of New Mexico to tax commissioners, Santa Fe, N. Mex., 1921–22.

28 per cent, Colfax County 19 per cent, Grant County 12 per cent, and Lincoln County 6 per cent. Dry and siliceous ores yielded 64 per cent of the total.

### SILVER.

The silver recoverable from ore and gravel mined in New Mexico in 1922 amounted to 752,240 fine ounces, valued at $752,240. Of the total quantity Catron County produced 43 per cent from the siliceous ore of the Mogollon district; Grant County 20 per cent, chiefly from the Central, Chloride Flat, and Pinos Altos districts; Sierra County 18 per cent, chiefly from the Lake Valley and Hillsboro districts; and Hidalgo County 16 per cent, from the Eureka, Lordsburg, and Steins districts. Placer mines yielded 39 ounces of silver.

Dry and siliceous gold and silver ores, chiefly from Catron, Grant, Hidalgo, and Sierra counties, yielded 82 per cent; copper ores, chiefly from Hidalgo and Sierra counties, 15 per cent; and lead ores, chiefly from Grant, Hidalgo, and Socorro counties, 2 per cent.

### COPPER.

The recoverable copper in the ore mined in New Mexico in 1922 amounted to 31,937,207 pounds, valued at $4,311,523. Of this total 99 per cent was produced in Grant and Hidalgo counties, chiefly from the Chino Copper Co.'s operation in the Central district and from the Lordsburg district. Copper ore yielded 99 per cent of the total.

### LEAD.

The recoverable lead in the ore mined in New Mexico in 1922 amounted to 3,012,223 pounds, valued at $165,672. The principal lead-producing districts were the Central and Pinos Altos districts, Grant County; the Gallinas Mountains district, Lincoln County; the Magdalena district, Socorro County; and the Lordsburg district, Hidalgo County.

### ZINC.

The total zinc recoverable from ore mined in New Mexico in 1922 amounted to 4,496,806 pounds, valued at $256,318. The principal zinc-producing districts were the Central district, Grant County, and the Magdalena district, Socorro County.

### OUTPUT OF ORE AND METAL CONTENT.

*Ore and metals produced in New Mexico in 1922.*

| Source. | Ore. | Gold. | Silver. | Copper. | Lead. | Zinc. |
|---|---|---|---|---|---|---|
| | *Short tons.* | *Fine ounces.* | *Fine ounces.* | *Pounds.* | *Pounds.* | *Pounds.* |
| Dry gold ore | 7,276 | 5,521.59 | 6,384 | 18,359 | 2,712 | ..... |
| Dry gold and silver ore | 96 | 26.99 | 637 | 2,557 | ..... | ..... |
| Dry silver ore | 70,755 | 7,308.41 | 607,790 | 12,560 | 640,781 | ..... |
| Copper ore | 1,477,166 | 6,805.80 | 111,624 | 31,669,547 | ..... | ..... |
| Copper-lead ore | 1,893 | ..... | 11,015 | 213,072 | 700,072 | ..... |
| Lead ore | 3,038 | 111.02 | 14,751 | 21,112 | 957,508 | ..... |
| Lead-zinc ore | 6,915 | ..... | ..... | ..... | 711,150 | 2,748,480 |
| Zinc ore | 9,781 | ..... | ..... | ..... | ..... | 1,748,326 |
| | 1,576,920 | 19,773.81 | 752,201 | 31,937,207 | 3,012,223 | 4,496,806 |
| Placers | ..... | 190.21 | 39 | ..... | ..... | ..... |
| | 1,576,920 | 19,964.02 | 752,240 | 31,937,207 | 3,012,223 | 4,496,806 |

*Metallic content of ores sold or treated in New Mexico in 1922.*

**Dry and siliceous gold and silver ores.**

| County. | Ore. | Gold. | Silver. | Copper. | Lead. | Zinc. |
|---|---|---|---|---|---|---|
| GOLD ORES. | *Short tons.* | *Fine ounces.* | *Fine ounces.* | *Pounds.* | *Pounds.* | *Pounds.* |
| Colfax | 3,730 | 3,693.00 | 563 | | | |
| Grant | 979 | 652.90 | 4,172 | 16,768 | 2,712 | |
| Hidalgo | 66 | 1.01 | 1,211 | 1,591 | | |
| Lincoln | 2,500 | 1,160.38 | 420 | | | |
| Socorro | 1 | 10.00 | 18 | | | |
| Taos | | 4.30 | | | | |
| | 7,276 | 5,521.59 | 6,384 | 18,359 | 2,712 | |
| GOLD AND SILVER ORES. | | | | | | |
| Grant | 96 | 26.99 | 637 | 2,557 | | |
| SILVER ORES. | | | | | | |
| Catron | 48,106 | 6,875.69 | 322,460 | | | |
| Grant | 11,514 | 323.98 | 134,100 | 7,640 | 632,035 | |
| Hidalgo | 1,179 | 28.01 | 27,934 | 4,112 | | |
| Sierra | 9,828 | 13.00 | 118,689 | 576 | 8,746 | |
| Socorro | 128 | | 2,548 | 232 | | |
| Torrance | | 67.73 | 2,059 | | | |
| | 70,755 | 7,308.41 | 607,790 | 12,560 | 640,781 | |

**Copper ores.**

| | | | | | | |
|---|---|---|---|---|---|---|
| Grant | 1,416,920 | 1,193.98 | 6,242 | 28,409,857 | | |
| Hidalgo | 60,050 | 5,492.81 | 86,814 | 3,215,659 | | |
| Luna | 2 | | 227 | 549 | | |
| Santa Fe | 9 | 1.00 | 27 | 2,003 | | |
| Sierra | 137 | 118.01 | 18,153 | 38,195 | | |
| Socorro | 32 | | 148 | 1,544 | | |
| Torrance | 16 | | 13 | 1,740 | | |
| | 1,477,166 | 6,805.80 | 111,624 | 31,669,547 | | |

**Copper-lead ores.**

| | | | | | | |
|---|---|---|---|---|---|---|
| Lincoln | 1,893 | | 11,015 | 213,072 | 700,072 | |

**Lead ores.**

| | | | | | | |
|---|---|---|---|---|---|---|
| Dona Ana | 43 | | 413 | | 12,576 | |
| Grant | 1,496 | 27.01 | 5,661 | 2,074 | 489,035 | |
| Hidalgo | 769 | 66.01 | 4,486 | 11,621 | 191,706 | |
| Luna | 192 | 18.00 | 749 | 1,130 | 43,000 | |
| Socorro | 538 | | 3,442 | 6,287 | 221,191 | |
| | 3,038 | 111.02 | 14,751 | 21,112 | 957,508 | |

**Zinc ores.**

| | | | | | | |
|---|---|---|---|---|---|---|
| Grant | 8,997 | | | | | 1,333,440 |
| Luna | 54 | | | | | 24,228 |
| Socorro | 730 | | | | | 390,658 |
| | 9,781 | | | | | 1,748,326 |

**Lead-zinc ores.**

| | | | | | | |
|---|---|---|---|---|---|---|
| Santa Fe | 40 | | | | 8,800 | 19,840 |
| Socorro | 6,875 | | | | 702,350 | 2,728,640 |
| | 6,915 | | | | 711,150 | 2,748,480 |

## PLACER OUTPUT.

*Placer output of gold and silver in New Mexico in 1922.*

| County. | Gold. | | Silver. | | Total value. |
|---|---|---|---|---|---|
| | Fine ounces. | Value. | Fine ounces. | Value. | |
| Colfax | 71.21 | $1,472 | 7 | $7 | $1,479 |
| Grant | 100.57 | 2,079 | 32 | 32 | 2,111 |
| Lincoln | 7.59 | 157 | ..... | ..... | 157 |
| Santa Fe | 10.84 | 224 | ..... | ..... | 224 |
| | 190.21 | 3,932 | 39 | 39 | 3,971 |
| Total, 1921 | 400.59 | 8,281 | 61 | 61 | 8,342 |
| Decrease, 1922 | 210.38 | 4,349 | 22 | 22 | 4,371 |

## SMELTERS.

The only smelter in operation in New Mexico in 1922 was the zinc oxide plant at Waldo, near Cerrillos. Smelters receiving ore from New Mexico were the lead and copper plants of the El Paso Smelting Works at El Paso, Tex.; the Copper Queen copper smelter and the Calumet & Arizona copper smelter at Douglas, Ariz.; the Ozark zinc-lead oxide plant at Coffeyville, Kans.; and the Empire Zinc Co.'s zinc oxide plant at Canon City, Colo. Small shipments of zinc ore were shipped to Collinsville, Okla., and Depue, Ill.

## MINING INDUSTRY.

A salient feature in the mining industry of New Mexico in 1922 was the renewal of mining, milling, and smelting of copper ore, especially at the large milling plant of the Chino Copper Co. at Hurley. This revival and similar activity in Arizona resulted in providing a market for fluxing and siliceous ores from the Lordsburg, Silver City, Lake City, and Pinos Altos mines and was supplemented by the steadying influence of the fixed price of $1 an ounce for silver. Other noteworthy features were a renewal of gold production at Baldy, the testing of gold ores at Nogal, the maintenance of gold and silver production at Mogollon, the renewal of zinc production at Hanover and Kelly, the renewal of silver production throughout Sierra County, the continuation of lead-silver shipments from the Volcano mine at Steins, and the idleness of the gold districts of Golden, Orogrande, and Whiteoaks.

*Mine production of gold, silver, copper, lead, and zinc in New Mexico in 1922, by counties.*

| County. | Number of mines producing. | Ore (short tons). | Gold.[a] | | Silver.[a] | |
|---|---|---|---|---|---|---|
| | | | Fine ounces. | Value. | Fine ounces. | Value. |
| Catron | 3 | 48,106 | 6,875.69 | $142,133 | 322,460 | $322,460 |
| Colfax | 8 | 3,730 | 3,764.21 | 77,813 | 570 | 570 |
| Dona Ana | 4 | 43 | ..... | ..... | 413 | 413 |
| Grant | 36 | 1,440,002 | 2,325.43 | 48,071 | 150,844 | 150,844 |
| Hidalgo | 13 | 62,064 | 5,587.84 | 115,511 | 120,445 | 120,445 |
| Lincoln | 4 | 4,393 | 1,167.97 | 24,144 | 11,435 | 11,435 |
| Luna | 5 | 248 | 18.00 | 373 | 976 | 976 |
| Santa Fe | 3 | 49 | 11.84 | 244 | 27 | 27 |
| Sierra | 9 | 9,965 | 131.01 | 2,708 | 136,842 | 136,842 |
| Socorro | 3 | 8,304 | 10.00 | 207 | 6,156 | 6,156 |
| Taos | 2 | ..... | 72.03 | 1,489 | 2,059 | 2,059 |
| Torrance | 1 | 16 | ..... | ..... | 13 | 13 |
| Total, 1921 | 91 | 1,576,920 | 19,964.02 | 412,693 | 752,240 | 752,240 |
| | 49 | 611,576 | 9,521.26 | 196,822 | 571,899 | 571,899 |
| Increase, 1922 | 42 | 965,344 | 10,442.76 | 215,871 | 180,341 | 180,341 |

| County. | Copper. | | Lead. | | Zinc. | | Total value. |
|---|---|---|---|---|---|---|---|
| | Pounds. | Value. | Pounds. | Value. | Pounds. | Value. | |
| Catron | ..... | ..... | ..... | ..... | ..... | ..... | $464,593 |
| Colfax | ..... | ..... | ..... | ..... | ..... | ..... | 78,383 |
| Dona Ana | ..... | ..... | 12,576 | $691 | ..... | ..... | 1,104 |
| Grant | 28,438,896 | $3,839,251 | 1,123,782 | 61,808 | 1,333,440 | $76,006 | 4,175,980 |
| Hidalgo | 3,232,983 | 436,453 | 191,706 | 10,544 | ..... | ..... | 682,953 |
| Lincoln | 213,072 | 28,765 | 700,072 | 38,504 | ..... | ..... | 102,848 |
| Luna | 1,679 | 227 | 43,000 | 2,365 | 24,228 | 1,381 | 5,322 |
| Santa Fe | 2,003 | 270 | 8,800 | 484 | 19,840 | 1,131 | 2,156 |
| Sierra | 38,771 | 5,234 | 8,746 | 481 | ..... | ..... | 145,265 |
| Socorro | 8,063 | 1,088 | 923,541 | 50,795 | 3,119,298 | 177,800 | 236,046 |
| Taos | ..... | ..... | ..... | ..... | ..... | ..... | 3,548 |
| Torrance | 1,740 | 235 | ..... | ..... | ..... | ..... | 248 |
| Total, 1921 | 31,937,207 | 4,311,523 | 3,012,223 | 165,672 | 4,496,806 | 256,318 | 5,898,446 |
| | 14,267,338 | 1,840,487 | 678,601 | 30,537 | 228,000 | 11,400 | 2,651,145 |
| Increase, 1922 | 17,669,869 | 2,471,036 | 2,333,622 | 135,135 | 4,268,806 | 244,918 | 3,247,301 |

[a] Includes placer production.

*Gold and silver produced at mills in New Mexico, 1921–22.*

| Year. | Ore to gold and silver mills. | Gold in bullion. | Silver in bullion. | Ore to concentrating mills. |
|---|---|---|---|---|
| | *Short tons.* | *Fine ounces.* | *Fine ounces.* | *Short tons.* |
| 1921 | 52,220 | 6,095.43 | 253,719 | 534,665 |
| 1922 | 54,512 | 10,526.13 | 262,663 | 1,425,824 |
| Increase, 1922 | 2,292 | 4,430.70 | 8,944 | 891,159 |

*Mine production of metals from New Mexico crude ore shipped to smelters, 1922, by counties.*

| County. | Ore. | Gold. | Silver. | Copper. | Lead. | Zinc. |
|---|---|---|---|---|---|---|
| | *Short tons.* | *Fine ounces.* | *Fine ounces.* | *Pounds.* | *Pounds.* | *Pounds.* |
| Dona Ana | 43 | ..... | 413 | ..... | 12,576 | ..... |
| Grant | 14,002 | 955.98 | 144,697 | 32,583 | 1,123,788 | 21,773 |
| Hidalgo | 62,064 | 5,587.84 | 120,445 | 3,232,983 | 191,706 | ..... |
| Lincoln | 1,893 | ..... | 11,015 | 213,072 | 700,072 | ..... |
| Luna | 248 | 18.00 | 976 | 1,679 | 42,998 | 24,228 |
| Santa Fe | 49 | 1.00 | 27 | 2,003 | 8,800 | 19,840 |
| Sierra | 9,965 | 131.00 | 136,842 | 38,771 | 8,746 | ..... |
| Socorro | 8,304 | 10.00 | 6,156 | 8,063 | 923,541 | 3,119,298 |
| Torrance | 16 | ..... | 13 | 1,739 | ..... | ..... |
| | 96,584 | 6,703.82 | 420,584 | 3,530,893 | 3,012,227 | 3,185,139 |

*Mine production of metals from New Mexico crude ore shipped to smelters, 1921–22.*

| Year. | Ore. | Gold. | Silver. | Copper. | Lead. | Zinc. |
|---|---|---|---|---|---|---|
| | *Short tons.* | *Fine ounces.* | *Fine ounces.* | *Pounds.* | *Pounds.* | *Pounds.* |
| 1921 | 24,691 | 1,338.84 | 224,687 | 633,936 | 659,601 | 228,000 |
| 1922 | 96,584 | 6,703.82 | 420,584 | 3,530,893 | 3,012,227 | 3,185,139 |
| Increase, 1922 | 71,893 | 5,364.98 | 195,897 | 2,896,957 | 2,352,626 | 2,957,139 |

*Mine production of metals from New Mexico concentrates, 1921–22.*

| Year. | Concentrates. | Gold. | Silver. | Copper. | Lead. | Zinc. |
|---|---|---|---|---|---|---|
| | *Short tons.* | *Fine ounces.* | *Fine ounces.* | *Pounds.* | *Pounds.* | *Pounds.* |
| 1921 | 40,549 | 1,686.40 | 93,432 | 13,633,402 | 19,000 | ..... |
| 1922 | 66,164 | 2,543.86 | 68,954 | 28,406,314 | ..... | 1,311,667 |
| Increase or decrease, 1922 | +25,615 | +857.46 | −24,478 | +14,772,912 | −19,000 | +1,311,667 |

*Mine production of metals from New Mexico crude ore and concentrates combined, shipped to smelters, 1921–22.*

| Year. | Ore and concentrates. | Gold. | Silver. | Copper. | Lead. | Zinc. |
|---|---|---|---|---|---|---|
| | *Short tons.* | *Fine ounces.* | *Fine ounces.* | *Pounds.* | *Pounds.* | *Pounds.* |
| 1921 | 65,240 | 3,025.24 | 318,119 | 14,267,338 | 678,601 | 228,000 |
| 1922 | 162,748 | 9,247.68 | 489,538 | 31,937,207 | 3,012,227 | 4,496,806 |
| Increase, 1922 | 97,508 | 6,222.44 | 171,419 | 17,669,869 | 2,333,626 | 4,268,806 |

*Gold and silver contained in bullion produced at mills in New Mexico, 1922.*

| Process. | Ore. | Gold. | Silver. | Quicksilver used. | Sodium cyanide used. |
|---|---|---|---|---|---|
| | *Short tons.* | *Fine ounces.* | *Fine ounces.* | *Pounds.* | *Pounds.* |
| Amalgamation | 6,406 | 4,940.61 | 1,055 | 270 | ..... |
| Cyanidation | 48,106 | 5,585.52 | 261,608 | ..... | 64,544 |
| | 54,512 | 10,526.13 | 262,663 | 270 | 64,544 |

## REVIEW BY COUNTIES.

### CATRON COUNTY.[2]

*Mogollon district (Cooney).*—The Mogollon Mines Co.'s 40-stamp 150-ton cyanidation and concentration mill was operated continuously on ore from its Last Chance–Top group and from the Confidence group (under option) and on custom ore from the Pacific and other claims of the Oaks Co. This company early in the year relinquished its option on the Deadwood mine, which was operated for the remainder of the year by the Sinaloa Exploration & Development Co. The Fanney mine and mill remained idle.

*Mine production of gold, silver, copper, and lead in Mogollon or Cooney district, Catron County, N. Mex., 1904–1922.*[a]

| Year. | Ore. | Gold. | Silver. | Copper. | Lead. | Total value. |
|---|---|---|---|---|---|---|
| | *Short tons.* | | *Fine ounces.* | *Pounds.* | *Pounds.* | |
| 1904 | 11,276 | $61,880 | 79,014 | 422,308 | ..... | $162,484 |
| 1905 | 15,534 | 97,158 | 240,943 | 295,175 | ..... | 288,735 |
| 1906 | 16,076 | 127,907 | 268,567 | ..... | ..... | 307,847 |
| 1907 | 20,698 | 105,413 | 418,338 | 150,000 | ..... | 411,516 |
| 1908 | 19,546 | 116,418 | 278,939 | ..... | ..... | 264,256 |
| 1909 | 23,945 | 111,464 | 249,413 | 46 | 49 | 241,167 |
| 1910 | 50,514 | 304,210 | 595,669 | ..... | ..... | 625,871 |
| 1911 | 102,219 | 531,358 | 1,067,038 | 1,873 | 1,862 | 1,097,206 |
| 1912 | 101,361 | 524,858 | 1,093,158 | 184 | 386 | 1,197,197 |
| 1913 | 115,739 | 619,886 | 1,306,766 | 4,418 | 1,217 | 1,409,912 |
| 1914 | 136,124 | 629,102 | 1,410,327 | ..... | 590 | 1,409,035 |
| 1915 | 119,710 | 509,165 | 1,301,059 | ..... | 2,426 | 1,168,916 |
| 1916 | 118,257 | 373,068 | 1,008,483 | 858 | 3,232 | 1,037,084 |
| 1917 | 111,934 | 258,620 | 722,642 | 414 | 1,593 | 854,327 |
| 1918 | 56,452 | 119,710 | 302,902 | 235 | 282 | 422,690 |
| 1919 | 56,531 | 148,136 | 382,800 | 9,521 | ..... | 578,643 |
| 1920 | 41,895 | 125,631 | 329,489 | 582 | 2,050 | 485,045 |
| 1921 | 48,870 | 126,791 | 310,774 | ..... | ..... | 437,565 |
| 1922 | 48,106 | 142,133 | 322,460 | ..... | ..... | 464,593 |
| Increase or decrease, 1922. | −764 | +15,342 | +11,686 | ..... | ..... | +27,028 |

[a] In reports prior to 1921 the production for the Mogollon district will be found under Socorro County.

### COLFAX COUNTY.

*Baldy district (Elizabethtown, Therma, Baldy).*—Lessees operated the Aztec mine and amalgamation mill on ore from pillars and stope filling. The Ajax 10-stamp amalgamating mill, with the Marathon mill used for regrinding, was operated for a short time in order to test the recovery by amalgamation alone. The Lowery and Little Nigger Gulch placers, at Elizabethtown, and the Paterson and Reece placers, on Willow Creek, were operated by sluicing and booming.

The Aztec mine from 1912 to 1920 produced $1,680,718 in bullion, ranging in fineness from 0.856 to 0.889 in gold and 0.105 to 0.142 in silver, and $243,079 in concentrates. Shortly after the discovery of the "bonanza" ore in 1914 the cost of producing gold was as low as $2 an ounce, but in 1919 it rose to $13.50 owing to the large amount of timbering required and other operating difficulties.[3]

[2] Catron County was separated from Socorro County at the legislative session in the spring of 1921. Officers took their seats July 1, 1921.

[3] Chase, C. A., and Muir, Douglas, The Aztec mine, Baldy, N. Mex.: Am. Inst. Min. and Met. Eng. Trans., vol. 68, pp. 270–281, 1923. See also Finlay, J. R., Report of appraisal of mining properties of New Mexico, Santa Fe, State Tax Commission, 1921–22.

*Mine production of gold, silver, copper, and lead in Elizabethtown district, Colfax County, N. Mex., 1904–1922.*[a]

| Year. | Ore. | Gold. | | Silver.[a] | Copper. | Lead. | Total value. |
|---|---|---|---|---|---|---|---|
| | | Placer. | Deep. | | | | |
| | *Short tons.* | | | *Fine ounces.* | *Pounds.* | *Pounds.* | |
| 1904 | 380 | $90,639 | $3,638 | 67 | | | $94,316 |
| 1905 | 13 | 31,994 | 445 | 157 | | | 31,749 |
| 1906 | | 14,492 | | 93 | | | 14,554 |
| 1907 | | 11,914 | | 83 | | | 11,969 |
| 1908 | | 11,274 | | 66 | | | 11,309 |
| 1909 | 83 | 16,037 | 1,705 | 127 | | | 17,808 |
| 1910 | 93 | 9,588 | 3,433 | 261 | | 2,182 | 13,258 |
| 1911 | 2,306 | 9,860 | 31,547 | 1,254 | 5,587 | | 42,770 |
| 1912 | 3,025 | 8,385 | 27,316 | 634 | 6,243 | | 37,121 |
| 1913 | 3,222 | 4,550 | 15,588 | 254 | 1,147 | 134 | 20,475 |
| 1914 | 2,860 | 4,930 | 63,129 | 577 | 11,083 | 154 | 69,858 |
| 1915 | 2,673 | 2,631 | 350,745 | 2,483 | 14,092 | 787 | 357,138 |
| 1916 | 6,064 | 5,039 | 417,258 | 2,803 | 447 | | 424,251 |
| 1917 | 10,180 | 5,739 | 342,994 | 2,381 | 4,784 | 930 | 352,081 |
| 1918 | 10,031 | 2,133 | 258,034 | 1,880 | 4,619 | | 263,288 |
| 1919 | 10,557 | 3,885 | 238,656 | 1,630 | | | 244,371 |
| 1920 | 5,637 | 1,634 | 81,722 | 607 | | | 84,018 |
| 1921 | | 3,447 | 5,361 | 52 | | | 8,860 |
| 1922 | 3,730 | 1,472 | 76,341 | 570 | | | 78,383 |

[a] Includes placer production.

## DONA ANA COUNTY.

A few small lots of lead-silver ore were shipped from the Organ Mountain district in 1922.

## GRANT COUNTY.[4]

*Burro Mountain district.*—No mining was done at the Burro Mountain mines of the Phelps Dodge Corporation, and the 2,000-ton table-concentration and oil-flotation mill, which had been closed March 31, 1921, also remained idle. Apparently no precipitates were made in 1922 from the heap leaching experiments at this property, but early in 1923 these experiments were renewed. In February, 1917, heap leaching was begun at Tyrone on 20,000 tons averaging 2.71 per cent of copper and was continued intermittently for three years, after which the test was discontinued because the concentrating mill required all the water pumped from the mine. The site for heap leaching was selected on a hillside easily accessible to the low-grade material to be treated. Surface benches were graded to retain the mill slime placed to assist in waterproofing the ground. The average depth of the heap was 6 feet and the analysis of the ore was copper 2.71 per cent, silica 66.0 per cent, iron 6.0 per cent, lime 0.3 per cent, sulphur 5.0 per cent, alumina 14.5 per cent. Similar tests were made at Bisbee, Ariz., beginning in April, 1917, with mine water and siliceous waste (below milling grade) from Sacramento Hill operations. The Bisbee heap averaged copper 1.3 per cent, silica 60.7 per cent, iron 10.5 per cent, lime 1.2 per cent, alumina 12.1 per cent, sulphur 9.9 per cent. These tests were continued for three years with various resting periods, at the end of which an extraction of 45.2 per cent of the copper contents was obtained, according to measurements and assays of the solution both on

[4] For a description of the geology of Bear Mountain, Burro Mountain, Chloride Flat, Fierro, Fleming, Georgetown, Hanover, Lone Mountain, Pinos Altos, and Santa Rita, see Paige, Sidney, U. S. Geol. Survey Geol. Atlas, Silver City folio (No. 199), 1916.

and off the heap. Later the heap was systematically sampled by means of a series of drill holes and pits and a steam-shovel cut through one end, and the general assay showed 0.36 per cent of copper, indicating an actual extraction of 72.3 per cent of the copper. The failure to recover more copper is credited to unaccounted-for losses of solution that drained directly into the ground and to losses due to floods during the rainy season.

*Central district.*—After a period of idleness from April 12, 1921, the Chino Copper Co. resumed operations shortly after April 1, 1922, and continued throughout the year at a rate equal to 45 per cent of the capacity of its 12,000-ton table and vanners-concentration and oil-flotation mill. This company's mines, which are of the "porphyry copper" type, are at Santa Rita, and the mill is at Hurley. The Empire Zinc Co.'s magnetic-separation mill at Hanover was put in operation in November, 1922, after being idle since November, 1920. This company's ores comprise both sulphide and carbonate zinc ores. A considerable quantity of comparatively high grade lead ore, low in silver, was shipped from the Lucky Bill mine, near Bayard. One car of silver ore was shipped from Georgetown. Early in 1922 mining was resumed on the iron deposits at Fierro, and a large quantity of iron ore was shipped to the Colorado Fuel & Iron Co.'s steel mill at Pueblo, Colo.

The thirteenth annual report of the Chino Copper Co., for the year ending December 31, 1922, says:

> Mining operations were resumed early in April after complete suspension for a period of 12 months. The first shovel was placed in commission on April 10, followed by the second shovel on April 19. Additional shovels were manned in May and June, so that by July 1 six shovels were in operation, and by the close of the year nine shovel crews were working in the various ore bodies.
>
> The total ore and waste removed by steam shovels during the period operated was 1,809,200 cubic yards. Of this amount 961,286 cubic yards was stripping, the remainder being equivalent to 1,659,781 tons of ore. Of this 1,419,567 tons were sent to the mill and 240,214 tons of semioxidized ore to the stock piles. From the beginning of steam-shovel operations, September 23, 1910, there has been removed a total of 44,029,010 cubic yards of material, of which 30,986,460 cubic yards was waste, the remainder being equivalent to 25,528,683 tons of ore. Of this 23,338,016 tons were shipped to the mill, 27,544 tons went direct from the mine to the smelter, the balance remaining in stock piles and reserve inventory.
>
> Of the ore shipped to the mill during the 1922 period of operations, 9.35 per cent came from the northwest ore body, 41.17 per cent came from the north ore body, 34.29 per cent was loaded from the south ore body, and 15.19 per cent from the southwest ore body. No ore was shipped from the ore stock piles to the mill.
>
> The average cost of steam-shovel operations, including removal of both ore and stripping, for the 8⅔ months period was 51.5 cents per cubic yard of material in place, as compared with 72.09 cents per cubic yard for the short period operated in 1921 and 69.16 cents for the year 1920 on the same basis. The above costs are exclusive of plant depreciation but include labor, supplies, general administration expenses, and State and county taxes. The cost of labor and supplies was 12.6 cents per cubic yard less than for the period worked in 1921 and 18.13 cents less than for the average of the year 1920. * * *
>
> One section of the Hurley mill was put in commission on April 7, the second section on May 7, the third section on June 7. The fourth section was put in operation the middle of August, and thereafter four sections continued in operation until the close of the year. For the 269 days operated there was a total of 1,416,869 tons of ore treated, equivalent to an average of 5,267 tons per day, as compared with 3,546 tons per day for the period operated in 1921 and 5,022 tons per day for the year 1920. The average copper content of the ore treated during the period was 1.55 per cent, or approximately 0.15 per cent lower than for 1921 and 0.21 per cent lower than for the year 1920. The total production of concentrates available for shipment was 64,341 dry tons, averaging 22.93 per cent copper, corresponding to a recovery of 20.83

pounds of copper per ton of ore, equivalent to an extraction of 66.99 per cent. The actual mill extraction was practically 70 per cent; the difference between this and the recovery shown above is due to the absorption of concentrates in settling tanks upon starting up, all apparatus having been thoroughly cleaned when shut down in 1921. The low actual extraction was due in part to the necessity of using a large tonnage of highly oxidized ore, but even more so to the deterioration of mill equipment during the long idle period. The lack of adequate flotation apparatus was another vitiating factor which is being remedied as rapidly as possible. The average cost of milling was 92 cents per ton, as compared with $1.37 per ton on the same basis for the short period of 1921 and $1.22 for the year 1920.

Production of copper as contained in the concentrates (and there were no other products shipped during the year) was 29,508,582 pounds, as compared to a production in 1921 of 9,504,601 pounds; for the year 1920 of 46,088,609 pounds; and for 1917, the last normal capacity year, 83,339,782 pounds. After allowing for smelter deduction the net output of refined copper for the operating period was 28,406,314 pounds. The average cost per pound of copper produced for the period, excluding any reserves for Federal taxes and charges for depreciation and after crediting precious-metal values and miscellaneous income, equal to 0.9 cents per pound, was 11.2 cents per pound, compared with 14.5 cents per pound for the previous year and 13.33 cents per pound for the year 1920 calculated in the same manner. * * *

During the past several years extended investigations have been conducted in connection with a process designed to improve recoveries from oxidized copper minerals. These having proceeded to such a point in the laboratory as to justify apparatus being erected on a commercial scale, a 300-ton unit was completed in September and has since continued in operation. Increased extractions were made from the beginning and have gradually approached a point closely approximating the very favorable pilot results attained on a smaller scale. This adaptation gives such promise that arrangements are in progress for applying it to a larger tonnage in the belief that eventually it can profitably and without undue cost be used on all ores that are oxidized or partially so which have been responsible for low or indifferent recoveries in the past. * * *

The total operating revenue derived from the production of copper during the nine months period of operation, plus the value of gold recovered, was $3,882,982.64. The operating expenses were $3,437,411.78, leaving a profit from operations of $445,570.86. Net miscellaneous income amounted to $247,415.66, making a total income of $692,986.52. Charges against income, including depreciation, obsolescence, shutdown expense, flotation, litigation settlement, etc., amounted to $1,541,772.09, resulting in a net loss or charge to surplus account for the year of $848,785.57.

No disbursements to stockholders were made during the year 1922. The total of dividends and capital distributions to stockholders up to and including December 31, 1922, amounts to $29,991,709.50.

There remained at the close of the calendar and fiscal year unmined and fully developed ore amounting to 101,802,771 tons of an average grade of 1.526 per cent copper, and in addition a mined reserve of 2,074,658 tons averaging 1.354 per cent copper in the stock piles at Santa Rita, and 88,465 tons in a special reserve for experimental purposes, averaging 1.37 per cent copper. The total ore, therefore, unmined and untreated is 103,965,894 tons of an average grade of 1.523 per cent copper. The total ore calculated as being developed as of January 1, 1921, and fully discussed in the eleventh annual report, including the ore removed to the close of operations December 31, 1922, is 127,335,159 tons of an average grade of 1.58 per cent copper. Of this total at the close of 1922, 25,532,388 tons of an average grade of 1.797 per cent had been mined. Of this amount 23,339,238 tons averaging 1.83 per cent copper had been shipped to the mill, and 30,027 tons averaging 7.815 per cent copper were shipped direct to the smelter, the remainder being on the stock pile and experimental reserve at the mine, as stated previously.

## GRANT COUNTY.

*Mine production of gold, silver, copper, lead, and zinc in Central district, Grant County, N. Mex., 1904–1922.*

| Year. | Ore. | Gold. | Silver. | Copper. | Lead. | Zinc. | Total value. |
|---|---|---|---|---|---|---|---|
| | *Short tons.* | | *Fine ounces.* | *Pounds.* | *Pounds.* | *Pounds.* | |
| 1904 | 21,048 | $5,582 | 282 | 3,264,208 | 11,977 | ..... | $430,607 |
| 1905 | 17,115 | ..... | ..... | 2,701,233 | ..... | ..... | 421,860 |
| 1906 | 39,155 | 4 | 1,524 | 3,075,001 | 235,070 | 99,656 | 614,648 |
| 1907 | 57,079 | 5,659 | 36,813 | 4,994,575 | 855,358 | 73,729 | 1,078,555 |
| 1908 | 41,852 | 777 | 296 | 3,994,502 | 29,122 | 251,070 | 541,231 |
| 1909 | 41,456 | 816 | 1,380 | 3,348,808 | 23,256 | 203,278 | 448,856 |
| 1910 | 37,008 | ..... | 404 | 2,679,630 | 155 | 1,285,500 | 409,955 |
| 1911 | 45,584 | 104 | 8,673 | 1,413,189 | 605,978 | 290,122 | 325,156 |
| 1912 | 1,136,290 | 998 | 29,586 | 29,512,812 | 2,172,676 | 2,205,824 | 5,138,779 |
| 1913 | 1,948,471 | 9,697 | 12,500 | 51,695,656 | 331,440 | 2,187,266 | 8,167,144 |
| 1914 | 1,934,020 | 102,971 | 42,971 | 55,222,874 | 365,079 | 3,669,513 | 7,672,759 |
| 1915 | 2,395,795 | 102,379 | 73,267 | 66,581,366 | 1,542,234 | 5,628,870 | 12,561,729 |
| 1916 | 3,134,791 | 133,962 | 116,953 | 74,228,606 | 2,122,797 | 7,278,575 | 19,592,956 |
| 1917 | 3,668,289 | 138,873 | 121,386 | 82,200,421 | 2,250,337 | 7,398,853 | 23,627,822 |
| 1918 | 3,908,816 | 128,577 | 111,175 | 77,547,300 | 2,857,887 | 8,826,967 | 20,400,099 |
| 1919 | 1,789,083 | 57,280 | 34,508 | 40,358,634 | 1,283,642 | 4,299,658 | 7,984,543 |
| 1920 | 1,882,172 | 68,962 | 26,190 | 44,400,088 | 925,513 | 6,134,593 | 8,838,068 |
| 1921 | 362,331 | 10,439 | 9,688 | 9,138,442 | 4,422 | 95,000 | 1,203,935 |
| 1922 | 1,426,783 | 24,537 | 11,326 | 28,408,184 | 19,395 | 1,333,440 | 3,966,369 |
| Increase, 1922 | 1,064,452 | 14,098 | 1,638 | 19,269,742 | 14,973 | 1,238,440 | 2,762,434 |

*Chloride Flat district.*—Lessees on the Baltic, Tight Squeeze, Grand Central, and Surprise claims shipped several thousand tons of silver ore, containing some lead, iron, and manganese in a lime gangue. From April to October a large quantity of iron-manganese ore was shipped to the Colorado Fuel & Iron Co.'s steel mill at Pueblo, Colo.

*Gold Hill district.*—The Cline 2-stamp amalgamation mill was operated for a time on oxidized gold ore from the Roosevelt-Gold Dollar group. One car of silver ore was shipped from the Good Luck group by the Cooperative Mining Co.

*Lone Cone district.*—Several hundred tons of silver ore was shipped from the Ruby Flat-Ben Hur group near Hurley.

*Pinos Altos district.*—Deep mines in the Pinos Altos district, idle in 1921, made a large production in 1922. The largest operation was that on the Houston-Thomas group, from which was shipped several thousand tons of silver ore, carrying lead and some gold, with a silica gangue. From the Langston mine was shipped several hundred tons of gold ore, containing also some silver, copper, and lead. Several hundred tons of lead ore with a small content of silver was shipped from the Lead Hill mine. During December several cars of gold and silver ore were shipped from the Martin dump and this was the beginning of heavy shipments that followed in the first half of 1923. Placer mines in the Pinos Altos district produced 100.57 fine ounces of gold and 32 ounces of silver in 1922.

*Mine production of gold, silver, copper, lead, and zinc in Pinos Altos district, Grant County, N. Mex., 1904–1922.*

| Year. | Ore. | Gold. | | Silver. | Copper. | Lead. | Zinc. | Total value. |
|---|---|---|---|---|---|---|---|---|
| | | Placer. | Deep. | | | | | |
| | *Short tons.* | | | *Fine ounces.* | *Pounds.* | *Pounds.* | *Pounds.* | |
| 1904 | 4,719 | $7,750 | $49,660 | 37,229 | 104,039 | 2,653 | ..... | $92,587 |
| 1905 | 6,348 | 10,943 | 31,442 | 39,585 | 103,469 | ..... | 160,779 | 82,442 |
| 1906 | 14,074 | 2,290 | 89,674 | 83,566 | 328,788 | ..... | ..... | 211,409 |
| 1907 | 14,841 | 3,782 | 78,723 | 65,862 | 322,195 | ..... | ..... | 190,413 |
| 1908 | 1,451 | 1,479 | 8,548 | 8,941 | 34,514 | 3,953 | ..... | 21,528 |
| 1909 | 38 | 3,584 | 2,083 | 1,377 | 6,200 | 418 | ..... | 7,207 |
| 1910 | 20 | 2,494 | 1,372 | 223 | 269 | 2,226 | ..... | 4,119 |
| 1911 | 355 | 4,043 | 1,406 | 5,616 | 3,232 | 4,063 | 16,773 | 9,968 |
| 1912 | 6,169 | 2,551 | 7,973 | 15,864 | 96,507 | 50,289 | 929,176 | 102,581 |
| 1913 | 3,643 | 1,646 | 29,162 | 28,276 | 100,555 | 83,067 | 366,056 | 87,626 |
| 1914 | 3,686 | [a]21,650 | 114,181 | 23,256 | 129,587 | 29,994 | 48,840 | 169,497 |
| 1915 | 7,024 | 1,979 | 31,823 | 19,856 | 377,463 | 130,638 | 454,710 | 172,463 |
| 1916 | 46,471 | 2,009 | 11,775 | 17,816 | 122,716 | 152,696 | 6,741,925 | 967,621 |
| 1917 | 45,993 | 3,153 | 7,731 | 10,803 | 49,945 | 80,989 | 5,556,892 | 607,189 |
| 1918 | 28,983 | 672 | 1,972 | 2,243 | 12,227 | 40,028 | 3,013,802 | 284,324 |
| 1919 | 2,912 | 1,074 | 5,044 | 2,524 | 14,452 | 20,906 | 267,671 | 32,281 |
| 1920 | 1,444 | 554 | 3,168 | 2,000 | 2,456 | 40,325 | 43,247 | 13,083 |
| 1921 | ..... | 2,368 | ..... | 37 | ..... | ..... | ..... | 2,405 |
| 1922 | 7,880 | 2,079 | 19,142 | 55,820 | 26,193 | 673,847 | ..... | 117,639 |
| Increase or decrease, 1922. | +7,880 | −289 | +19,142 | +55,783 | +26,193 | +673,847 | ..... | +115,234 |

[a] Placer and surface lode mines combined. Only small quantity recovered by actual placer methods. Fineness so similar, separation not practicable.

*Steeplerock district.*—Some development work was done in the Steeplerock district, but no ore was shipped in 1922.

*White Signal district.*—Two cars of copper ore were shipped from the Copper Glance mine, and two cars of lead ore from the Lucky Seven-Dandy group.

## HIDALGO COUNTY.[5]

*Apache district (Hachita).*—Several cars of copper ore, carrying a low content of silver, were shipped from the Apache mine.

*Eureka district (Hachita).*—Several cars of silver and lead-silver ore were shipped from the Eureka district.

*Lordsburg district (including Pyramid and Virginia or Shakespeare districts).*—The reopening of copper smelters at El Paso, Tex., and Douglas, Ariz., early in 1922 made a market for the highly siliceous gold-silver-copper ore of the Lordsburg district. A large quantity of this ore was shipped from the Eighty-five mine to Douglas for use in the refinery operations of the Calumet & Arizona smelter. The Eighty-five mine is opened by a 1,300-foot vertical shaft. Much development work was done at this mine in 1922. Copper-silver-gold ore carrying a high content of silica was shipped from the Atwood mine to the copper department of the El Paso smelter and to Douglas smelters, and similar ore from the Bonney mine went to Douglas. From the dump of the Venus mine several hundred tons of silver ore was shipped to El Paso. Two cars of high-grade silver ore from the Last Chance mine were shipped to El Paso, and several hundred tons of lead-silver ore from the Anita mine was shipped to the lead department at the El Paso smelter.

[5] For review of districts in reports prior to 1920, see Grant County.

*Mine production of gold, silver, copper, and lead in Lordsburg district, Hidalgo County, N. Mex., 1904–1922.*[a]

| Year. | Ore. | Gold. | Silver. | Copper. | Lead. | Total value. |
|---|---|---|---|---|---|---|
| | *Short tons.* | | *Fine ounces.* | *Pounds.* | *Pounds.* | |
| 1904 | 250 | $1,184 | 2,580 | 18,200 | 12,000 | $5,582 |
| 1905 | 366 | 10 | 7,584 | 48,000 | ..... | 12,079 |
| 1906 | 1,743 | 5,168 | 27,261 | 212,601 | ..... | 64,465 |
| 1907 | 5,645 | 8,761 | 31,303 | 463,335 | 10,522 | 122,646 |
| 1908 | 7,532 | 10,617 | 9,889 | 259,079 | 11,363 | 50,534 |
| 1909 | 10,690 | 25,983 | 50,154 | 589,969 | 8,862 | 129,140 |
| 1910 | 29,220 | 59,798 | 130,324 | 1,627,591 | 19,662 | 337,742 |
| 1911 | 46,139 | 106,648 | 182,448 | 2,455,336 | 2,157 | 510,359 |
| 1912 | 55,340 | 144,859 | 275,251 | 3,155,585 | 4,562 | 835,015 |
| 1913 | 31,284 | 55,234 | 154,779 | 1,601,461 | 14,572 | 397,588 |
| 1914 | 38,964 | 101,080 | 232,647 | 2,614,674 | 30,049 | 578,658 |
| 1915 | 92,093 | 222,848 | 374,325 | 3,890,365 | 28,723 | 1,094,795 |
| 1916 | 118,966 | 267,148 | 373,074 | 4,755,179 | 30,478 | 1,684,508 |
| 1917 | 99,532 | 245,607 | 295,443 | 4,261,956 | 41,442 | 1,656,130 |
| 1918 | 55,015 | 130,858 | 153,236 | 2,214,996 | 17,831 | 832,464 |
| 1919 | 77,002 | 175,008 | 242,733 | 3,516,457 | 53,264 | 1,103,753 |
| 1920 | 55,307 | 153,461 | 182,000 | 2,695,674 | 98,312 | 855,530 |
| 1921 | 11,593 | 22,987 | 35,119 | 579,295 | 13,134 | 133,426 |
| 1922 | 61,291 | 114,911 | 107,511 | 3,216,585 | 102,291 | 662,287 |
| Increase, 1922 | 49,698 | 91,924 | 72,392 | 2,637,290 | 89,157 | 528,861 |

[a] In reports prior to 1920 the production for the Lordsburg district will be found under Grant County.

*Red Hill district.*—Several cars of ore having a low content of silver but a high content of lead were shipped from the Red Hill group.

*Steins district.*—The installation of a new hoisting plant, a compressor plant, and other equipment occupied the first half of the year at the Volcano mine, from which several hundred tons of silver ore was shipped in 1922.

### LINCOLN COUNTY.

*Nogal district.*—Continuation of mine development and trial operation of the 5-stamp amalgamation mill at the Helen Rae mine resulted in the marketing of a considerable quantity of gold-silver bullion before the project was abandoned.

*Red Cloud district (Gallinas Mountains).*—Two operators, one working from January to June and one from October 20 to December 31, shipped a large quantity of lead-copper-silver ore from the Red Cloud mine.

*Whiteoaks district.*—The Homestake amalgamation mill, with a record of small but continuous production of gold bullion for many years up to 1920, inclusive, remained idle in 1922.

### LUNA COUNTY.

*Cooks Peak district.*—A car of lead oxidized ore and two cars of zinc carbonate ore were all that were shipped from the Cooks Peak district, which until 1919 had been a contributor of appreciable quantities of lead and zinc ores.

*Victorio district (Gage).*—Several hundred tons of lead-silver ore was shipped from the Helen & Jessie mine and from the Chance group.

### OTERO COUNTY.

No ores were shipped from the Orogrande district, which was until 1922 a contributor of iron ores to the steel plant at Pueblo, Colo., and until 1921 of iron-copper-gold ores to the El Paso smelter.

## SAN MIGUEL COUNTY.

The Pecos mines, at the junction of Willow Creek and Pecos River, under development during 1918–1921, were idle in 1922 and were allowed to fill with water.

## SANTA FE COUNTY.

*Cerrillos district.*—One car of lead-zinc ore was shipped from the Cerrillos district in 1922. The Grubnau zinc oxide plant, at Waldo, was operated part of the year.

*New Placers district (Golden).*—Several small lots of placer gold and one lot of copper ore were marketed from the Golden district in 1922.

## SIERRA COUNTY.

*Mine production of gold, silver, copper, lead, and zinc in Sierra County, N. Mex., 1904–1922.*

| Year. | Ore. | Gold. | | Silver. | Copper. | Lead. | Zinc. | Total value. |
|---|---|---|---|---|---|---|---|---|
| | | Placer. | Deep. | | | | | |
| | *Short tons.* | | | *Fine ounces.* | *Pounds.* | *Pounds.* | *Pounds.* | |
| 1904 | 1,295 | $22,979 | $51,617 | 17,055 | 16,700 | ..... | ..... | $86,632 |
| 1905 | 3,516 | 47,878 | 51,164 | 8,700 | 46,664 | ..... | ..... | 11,613 |
| 1906 | 3,246 | 1,509 | 16,539 | 8,102 | 5,995 | ..... | ..... | 24,633 |
| 1907 | 700 | 595 | 7,629 | 2,250 | 5,425 | 9,548 | ..... | 11,300 |
| 1908 | 680 | 1,979 | 16,039 | 8,589 | 12,874 | 6,075 | ..... | 24,524 |
| 1909 | 4,294 | ..... | 10,450 | 25,698 | 25,838 | 49,023 | ..... | 29,280 |
| 1910 | 8,306 | 584 | 11,113 | 15,778 | 2,448 | 11,274 | ..... | 21,024 |
| 1911 | 5,036 | 823 | 26,962 | 16,487 | 5,374 | 28,088 | ..... | 38,459 |
| 1912 | 252 | 1,546 | 2,597 | 11,236 | 8,988 | 21,001 | ..... | 13,481 |
| 1913 | 269 | 423 | 434 | 2,529 | 2,568 | 32,685 | ..... | 4,221 |
| 1914 | 98 | 442 | 1,305 | 3,982 | 14,436 | 5,743 | ..... | 6,093 |
| 1915 | 438 | 1,757 | 1,079 | 316 | 2,228 | 24,617 | 7,492 | 5,472 |
| 1916 | 935 | ..... | 1,468 | 2,138 | 14,427 | 126,609 | 7,045 | 16,104 |
| 1917 | 619 | 331 | 1,470 | 8,712 | 11,828 | 80,116 | ..... | 19,099 |
| 1918 | 801 | ..... | 568 | 18,536 | 42,053 | 25,915 | ..... | 31,331 |
| 1919 | 4,041 | ..... | 3,948 | 67,658 | 31,661 | 49,679 | ..... | 88,247 |
| 1920 | 6,957 | ..... | 15,896 | 117,089 | 43,826 | 84,264 | ..... | 158,328 |
| 1921 | 3,856 | ..... | 1,323 | 77,366 | 1,395 | 40,934 | ..... | 80,711 |
| 1922 | 9,965 | ..... | 2,708 | 136,842 | 38,771 | 8,746 | ..... | 145,265 |
| Increase or decrease, 1922 | +6,109 | ..... | +1,385 | +59,476 | +37,376 | −32,188 | ..... | +64,554 |

Sierra County's production in 1922 almost equaled that of 1920, after decreasing greatly in 1921.

*Chloride district (Apache, Cuchillo Negro).*—At the Midnight-Tidal Wave property some ore was treated at the 50-ton table-concentration and oil-flotation mill, and a car of concentrates assaying more than 100 ounces silver to the ton was marketed. The Silver Monument mine marketed two cars of ore or concentrates with a high content of silver.

*Hillsboro district (Las Animas).*—A car of copper-gold-silver ore was shipped from the Bonanza mine.

*Kingston district.*—Several cars of silver ore were shipped from the Lady Franklin mine, and a small lot of silver ore from the Brush Heap property.

*Lake Valley district.*—With the resumption in April of copper mining throughout the Southwest and the resumption or increase

of operations at the copper smelters and refineries, the siliceous ores of the Lake Valley mine, carrying manganese, iron, and silver, were again in demand, and a large quantity of ore was shipped during the remainder of the year.

*Sierra Blanca district (Bromide).*—One small lot of silver ore was shipped from the Log Cabin property.

### SOCORRO COUNTY.

*Magdalena district (Kelly).*—There were no company operations at the Ozark Smelting & Mining Co.'s property in 1922, but lessees mined and shipped a large quantity of copper sulphide, lead oxidized, zinc-lead sulphide and oxidized, and zinc oxidized ores. This company's 100-ton flotation mill, for the treatment of zinc sulphide ores, was idle. Several small lots of lead and lead-zinc ores were shipped from other properties. The Empire Zinc Co.'s magnetic-separation mill was dismantled, and the magnetic machines were moved to Canon City, Colo. No shipments of ore were made from the Empire Zinc Co.'s property.

### TAOS COUNTY.

Several bars of gold-silver bullion reached a market early in 1922 as a final clean-up of the operation of the Caribel cyanidation mill during the last three months of 1921. Lessees proposing to unwater the Black Copper Co.'s property (idle since 1907) produced a small bar of gold by panning and amalgamating a small quantity of ore left from previous operations. The property has a 252-foot shaft and 680 feet of drifts and is equipped with a 5-stamp amalgamation and concentration mill.

### TORRANCE COUNTY.

A small car of copper ore was shipped from the surface outcrops of copper minerals in limestone and shaly limestone of the "Red Beds" of the Carocito district, north of Scholle, from which several thousand tons of copper ore was shipped in 1916–1919.

# SILVER, COPPER, AND LEAD IN TEXAS.

(MINES REPORT.)

By Charles W. Henderson.

*Mine production of silver, copper, and lead in Texas, 1921–22.*

| Year. | Silver. | | Copper. | | Lead. | | Total value. |
|---|---|---|---|---|---|---|---|
| | Fine ounces. | Value. | Pounds. | Value. | Pounds. | Value. | |
| 1921 | [a] 516,766 | [a] $516,766 | | | | | [a] $516,766 |
| 1922 | 644,980 | 644,980 | 4,290 | $579 | 8,016 | $441 | 646,000 |
| Increase, 1922 | 128,214 | 128,214 | 4,290 | 579 | 8,016 | 441 | 129,234 |

[a] Revised figures.

*Hudspeth County.*—One small lot of silver-copper ore was shipped from the Mohawk property and two cars of similar ore from the Sancho Pango mine, in the Allamoore district. A car of lead-silver ore was shipped from the Black Hill mine, in the Sierra Blanca district.

*Presidio County.*—The Presidio Mining Co. has been engaged since 1884 in mining silver ore from replacement deposits in limestone at the Presidio mine, in the Shafter district. The property is equipped with a 125-ton cyanidation mill, where crushing is first done with stamps, followed by fine grinding in tube mills, agitated in Pachuca agitators, followed by filters and Merrill zinc precipitation presses. This mine has produced the greater part of the silver output of Texas, which is 16,455,480 fine ounces, having a commercial value of $12,086,879.

# GOLD, SILVER, COPPER, LEAD, AND ZINC IN IDAHO.

(MINES REPORT.)

By C. N. Gerry.[1]

## PRODUCTION.

### SUMMARY.

The value of the mine production of gold, silver, copper, lead, and zinc in Idaho increased more than 14 per cent in 1922, notwithstanding decreases in the output of gold and lead. The metal output, however, was considerably less than the average of the last ten years. Dividends for 1922 amounted to $2,582,095.

*Mine production of gold, silver, copper, lead, and zinc in Idaho in 1921 and 1922.*

| Year. | Number of producers. | Ore. | Gold.[a] | Silver.[a] | Copper. | Lead. | Recoverable zinc. | Total value. |
|---|---|---|---|---|---|---|---|---|
| | | *Short tons.* | | *Fine ounces.* | *Pounds.* | *Pounds.* | *Pounds.* | |
| 1921 | 225 | 1,514,447 | $545,731 | 6,080,528 | 1,688,195 | 198,469,119 | 33,463 | $15,776,819 |
| 1922 | 248 | 1,436,884 | 501,405 | 6,081,865 | 3,282,842 | 195,834,205 | 4,109,131 | 18,031,555 |
| Increase or decrease, 1922 | +23 | −77,563 | −44,326 | +1,337 | +1,594,647 | −2,634,914 | +4,075,668 | +2,254,736 |
| Total, 1863–1922 | ..... | ..... | 133,859,749 | 258,946,538 | 133,531,013 | 6,892,299,443 | 434,449,501 | 737,438,228 |

[a] Includes placer production.

### TREND OF MINING IN IDAHO.

Since 1863 Idaho has been a large producer of the five metals, and of the total value to the end of 1922 lead represented $350,270,171, silver $188,349,323, gold $133,859,749, copper $22,884,161, and zinc $42,074,824.

The history of mining in Idaho has been principally a record of the mining of silver and lead, though gold was an important product, especially in the early years. From 1863 to 1870 the output of placer gold and silver was the main feature of the industry. From 1871 to 1880 the output of gold decreased considerably, though the value of the gold and silver from deep mines, especially from Owyhee County, was large. The mines of Silver City and Delamar pro-

[1] Much work in the preparation of this report, especially in the compilation of tables, was done by B. N. Patchell, of the United States Geological Survey.

duced much gold and silver in the early years, but the greater part of the output was mined from 1890 to 1912. In 1881 the silver-lead mines in Shoshone and Blaine (formerly Alturas) counties became prominent, and the mines of Shoshone County have been regular producers since. Idaho produced nearly 12,500,000 ounces of silver in 1914 and more than 393,000,000 pounds of lead in 1917. The production of copper began in the eighties but was not large until 1904, after which the yearly average was about 5,500,000 pounds. Shipments of zinc ore began in 1905, and the output of zinc reached a record of more than 86,500,000 pounds in 1916. With new hydraulic and dredge installations the output of gold may be increased, and the output of copper and zinc will probably reach an average of recent years, but it does not seem probable that the output of silver and lead will reach the former high records unless large new deposits are discovered.

*Mine production of gold, silver, copper, lead, and zinc in Idaho, 1863–1922, by periods.*

| Period. | Gold. | | Silver. | | Copper. | |
|---|---|---|---|---|---|---|
| | Fine ounces. | Value. | Fine ounces. | Value. | Pounds. | Value. |
| 1863–1870 | 2,499,887.00 | $51,675,200 | 2,176,738 | $2,900,000 | ..... | ..... |
| 1871–1880 | 907,453.00 | 18,758,707 | 3,152,989 | 3,887,778 | ..... | ..... |
| 1881–1890 | 852,150.00 | 17,615,293 | 24,866,722 | 25,597,231 | 380,781 | $53,564 |
| 1891–1900 | 993,496.00 | 20,537,380 | 44,856,082 | 30,757,036 | 3,685,465 | 447,579 |
| 1901–1910 | 675,977.13 | 13,973,564 | 74,594,495 | 43,284,835 | 60,330,873 | 9,391,986 |
| 1911–1922 | 546,618.38 | 11,299,605 | 109,299,512 | 81,922,443 | 69,133,894 | 12,991,032 |
| | 6,475,581.51 | 133,859,749 | 258,946,538 | 188,349,323 | 133,531,013 | 22,884,161 |

| Period. | Lead. | | Recoverable zinc. | | Total value. |
|---|---|---|---|---|---|
| | Pounds. | Value. | Pounds. | Value. | |
| 1863–1870 | ..... | ..... | ..... | ..... | $54,575,200 |
| 1871–1880 | 700,000 | $38,200 | ..... | ..... | 22,684,685 |
| 1881–1890 | 329,801,639 | 14,343,777 | ..... | ..... | 57,609,865 |
| 1891–1900 | 965,942,461 | 37,416,132 | ..... | ..... | 89,158,127 |
| 1901–1910 | 2,137,123,188 | 99,592,717 | 17,273,912 | $988,048 | 167,231,150 |
| 1911–1922 | 3,458,732,155 | 198,879,345 | 417,175,589 | 41,086,776 | 346,179,201 |
| | 6,892,299,443 | 350,270,171 | 434,449,501 | 42,074,824 | 737,438,228 |

The general decrease in placer gold and in the different kinds of ore is shown in the following tables of classification for the last 12 years. No separate table was made for copper-lead ore, in which there was a good increase in 1921 and 1922.

*Gold and silver produced at placer mines in Idaho, 1911–1922, in fine ounces.*

| Year. | Gold. | Silver. | Year. | Gold. | Silver. |
|---|---|---|---|---|---|
| 1911 | 19,559.35 | 4,851 | 1918 | 13,371.33 | 3,283 |
| 1912 | 30,574.40 | 7,278 | 1919 | 9,227.63 | 1,902 |
| 1913 | 33,574.81 | 7,309 | 1920 | 5,505.76 | 1,119 |
| 1914 | 33,884.46 | 7,071 | 1921 | 8,784.90 | 1,686 |
| 1915 | 28,294.05 | 5,935 | 1922 | 8,899.64 | 1,959 |
| 1916 | 21,724.87 | 4,712 | | | |
| 1917 | 6,541.80 | 1,194 | | 219,943.00 | 48,299 |

*Content of ore sold or treated in Idaho, 1911–1922.*

**Dry and siliceous ore.**

| Year. | Ore. | Gold. | Silver. | Copper. | Lead. | Recoverable zinc. |
|---|---|---|---|---|---|---|
| | *Short tons.* | *Fine ounces.* | *Fine ounces.* | *Pounds.* | *Pounds.* | *Pounds.* |
| 1911 | 122,708 | 38,040.41 | 332,864 | 10,354 | 18,843 | ..... |
| 1912 | 88,430 | 29,856.42 | 232,583 | 10,573 | 27,981 | ..... |
| 1913 | 60,325 | 22,341.27 | 125,839 | 7,358 | 7,503 | ..... |
| 1914 | 43,513 | 17,582.57 | 39,002 | 5,433 | 4,376 | ..... |
| 1915 | 52,302 | 21,935.45 | 74,481 | 4,661 | 12,659 | ..... |
| 1916 | 71,683 | 25,496.72 | 112,519 | 40,391 | 114,994 | ..... |
| 1917 | 69,650 | 24,929.28 | 81,514 | 10,745 | 48,689 | ..... |
| 1918 | 46,315 | 14,253.45 | 69,936 | 3,703 | 8,470 | ..... |
| 1919 | 48,251 | 22,262.08 | 78,531 | 11,976 | 6,455 | ..... |
| 1920 | 39,811 | 13,806.37 | 91,752 | 50,437 | 17,540 | ..... |
| 1921 | 48,221 | 13,826.54 | 49,034 | 7,084 | 16,942 | ..... |
| 1922 | 25,766 | 9,084.94 | 91,377 | 19,252 | 25,995 | ..... |
| | 716,975 | 253,415.50 | 1,379,432 | 181,967 | 310,447 | ..... |

**Copper ore.**

| | | | | | | |
|---|---|---|---|---|---|---|
| 1911 | 40,061 | 4,492.30 | 254,095 | 3,975,384 | ..... | ..... |
| 1912 | 98,848 | 2,039.30 | 451,918 | 6,663,229 | 13,920 | ..... |
| 1913 | 143,865 | 5,032.26 | 414,371 | 8,823,011 | 146 | ..... |
| 1914 | 93,040 | 1,076.54 | 239,355 | 4,986,206 | ..... | ..... |
| 1915 | 74,901 | 3,997.33 | 171,931 | 5,510,427 | 843 | ..... |
| 1916 | 113,050 | 3,619.47 | 218,598 | 6,583,043 | ..... | ..... |
| 1917 | 103,224 | 3,960.99 | 232,840 | 6,225,486 | 11,803 | ..... |
| 1918 | 127,898 | 3,339.71 | 262,991 | 5,389,887 | ..... | ..... |
| 1919 | 51,546 | 962.13 | 246,983 | 2,545,044 | ..... | ..... |
| 1920 | 19,259 | 1,418.69 | 52,029 | 1,738,541 | 420 | ..... |
| 1921 | 10,322 | 1,258.62 | 23,987 | 1,105,511 | ..... | ..... |
| 1922 | 32,590 | 2,045.78 | 44,550 | 2,572,335 | 707 | ..... |
| | 908,604 | 33,243.12 | 2,613,648 | 56,118,104 | 27,839 | ..... |

**Lead ore.**

| | | | | | | |
|---|---|---|---|---|---|---|
| 1911 | 1,559,724 | 3,843.44 | 7,059,990 | 1,049,599 | 240,412,348 | ..... |
| 1912 | 1,597,661 | 3,854.52 | 7,085,596 | 730,773 | 250,774,042 | ..... |
| 1913 | 1,598,344 | 3,404.44 | 7,806,445 | 624,089 | 267,685,316 | 77,795 |
| 1914 | 1,421,893 | 2,467.13 | 8,697,580 | 1,128,859 | 261,689,295 | ..... |
| 1915 | 1,656,688 | 2,306.28 | 9,791,944 | 1,393,961 | 294,551,932 | 52,299 |
| 1916 | 1,373,579 | 2,572.87 | 8,227,936 | 1,466,389 | 257,016,676 | ..... |
| 1917 | 1,448,285 | 2,567.41 | 8,063,768 | 1,250,215 | 275,019,571 | ..... |
| 1918 | 1,420,878 | 2,782.34 | 8,036,861 | 1,124,503 | 262,892,200 | ..... |
| 1919 | 1,149,951 | 1,970.50 | 4,757,259 | 564,415 | 160,572,291 | ..... |
| 1920 | 1,480,177 | 2,497.21 | 6,091,408 | 657,627 | 210,039,183 | ..... |
| 1921 | 1,446,710 | 2,467.70 | 5,688,577 | 449,883 | 198,322,374 | ..... |
| 1922 | 1,331,785 | 2,590.10 | 5,450,038 | 399,160 | 193,551,305 | 1,699,261 |
| | 17,485,675 | 33,323.94 | 86,757,402 | 10,839,473 | 2,872,526,533 | 1,829,355 |

**Zinc ore and lead-zinc ore.**

| | | | | | | |
|---|---|---|---|---|---|---|
| 1911 | 448,404 | 453.75 | 544,336 | 117,600 | 32,125,334 | 8,340,249 |
| 1912 | 481,362 | 491.59 | 513,883 | 75,628 | 33,361,192 | 13,905,502 |
| 1913 | 649,058 | 690.26 | 1,635,229 | 138,508 | 50,178,980 | 23,096,158 |
| 1914 | 676,903 | 732.54 | 3,496,508 | 324,689 | 86,832,398 | 42,012,435 |
| 1915 | 624,953 | 536.33 | 1,724,810 | 69,200 | 51,433,473 | 70,100,935 |
| 1916 | 1,159,711 | 557.71 | 3,736,757 | 386,304 | 117,938,464 | 86,505,219 |
| 1917 | 1,137,344 | 933.16 | 3,649,219 | 340,808 | 118,478,610 | 79,854,136 |
| 1918 | 496,423 | 251.89 | 797,563 | 4,669 | 31,785,172 | 45,161,712 |
| 1919 | 207,628 | 79.97 | 493,889 | ..... | 21,757,548 | 15,994,229 |
| 1920 | 414,139 | 166.56 | 865,305 | 22,000 | 39,327,525 | 27,932,326 |
| 1921 | 72 | ..... | ..... | ..... | ..... | 33,463 |
| 1922 | 20,600 | ..... | 34,412 | ..... | 1,923,153 | 2,409,870 |
| | 6,316,597 | 4,893.76 | 17,491,911 | 1,479,406 | 585,141,849 | 415,346,234 |

## ORE.

The quantity of ore sold or treated in Idaho decreased more than 5 per cent in 1922. Of the total output nearly 93 per cent was lead ore; copper ore represented more than 2 per cent; dry and siliceous ore, nearly 2 per cent; copper-lead ore, nearly 2 per cent; and lead-zinc ore, more than 1 per cent. These ores had the following value: Dry gold ore, $184,040; dry gold and silver ore, $6,772; dry silver ore, $92,395; copper ore, $434,144; lead ore, $16,299,647; zinc ore, $2,469; copper-lead ore, $551,079; and lead-zinc ore, $275,078. Most of the dry and siliceous ore was treated by amalgamation or cyanidation, and about half the copper ore was concentrated. The first-class shipping ore—90,820 tons—was largely lead ore and copper ore, and the averages of the crude shipping product are given on page 227. Most of the lead ore, copper-lead ore, and lead-zinc ore was milled; the results are stated in the table on concentrates (p. 226).

*Ore and metals produced in Idaho in 1922.*

| Source of product. | Ore. | | Gold. | | Silver. | |
|---|---|---|---|---|---|---|
| | Short tons. | Per cent. | Fine ounces. | Per cent. | Fine ounces. | Per cent. |
| Dry gold ore | 21,580 | 1.50 | 8,734.16 | 36.01 | 3,475 | 0.06 |
| Dry gold and silver ore | 257 | .02 | 193.81 | .80 | 2,304 | .04 |
| Dry silver ore | 3,929 | .27 | 156.97 | .65 | 85,598 | 1.41 |
| Copper ore | 32,590 | 2.27 | 2,045.78 | 8.43 | 44,550 | .73 |
| Lead ore | 1,331,785 | 92.69 | 2,590.10 | 10.68 | 5,450,038 | 89.61 |
| Zinc ore | 84 | ..... | ..... | ..... | ..... | ..... |
| Copper-lead ore | 26,143 | 1.82 | 1,635.00 | 6.74 | 459,529 | 7.56 |
| Lead-zinc ore | 20,516 | 1.43 | ..... | ..... | 34,412 | .56 |
| Total deep mines | 1,436,884 | 100.00 | 15,355.82 | 63.31 | 6,079,906 | 99.97 |
| Total placers | ..... | ..... | 8,899.64 | 36.69 | 1,959 | .03 |
| Total deep mines and placers, 1922 | 1,436,884 | ..... | 24,255.46 | 100.00 | 6,081,865 | 100.00 |
| Total deep mines and placers, 1921 | 1,514,447 | ..... | 26,399.73 | ..... | 6,080,528 | ..... |
| Increase or decrease, 1922 | −77,563 | ..... | −2,144.27 | ..... | +1,337 | ..... |

| Source of product. | Copper. | | Lead. | | Zinc. | |
|---|---|---|---|---|---|---|
| | Pounds. | Per cent. | Pounds. | Per cent. | Pounds. | Per cent. |
| Dry gold ore | 45 | ..... | 150 | ..... | ..... | ..... |
| Dry gold and silver ore | 288 | ..... | 7,693 | ..... | ..... | ..... |
| Dry silver ore | 18,919 | 0.58 | 18,152 | 0.01 | ..... | ..... |
| Copper ore | 2,572,335 | 78.36 | 707 | ..... | ..... | ..... |
| Lead ore | 399,160 | 12.16 | 193,551,305 | 98.84 | 1,699,261 | 41.35 |
| Zinc ore | ..... | ..... | ..... | ..... | 43,321 | 1.06 |
| Copper-lead ore | 292,095 | 8.90 | 333,045 | .17 | ..... | ..... |
| Lead-zinc ore | ..... | ..... | 1,923,153 | .98 | 2,366,549 | 57.59 |
| Total deep mines | 3,282,842 | 100.00 | 195,834,205 | 100.00 | 4,109,131 | 100.00 |
| Total deep mines, 1921 | 1,688,195 | ..... | 198,469,119 | ..... | 33,463 | ..... |
| Increase or decrease, 1922 | +1,594,647 | ..... | −2,634,914 | ..... | +4,075,668 | ..... |

## GOLD ORE.

Most of the gold ore was produced from mines in Boise County. Elmore, Idaho, and Lemhi counties, formerly large producers of gold ore, had a small output on account of transportation difficulties. The gold ore averaged $8.37 in gold and 0.16 ounce of silver to the ton.

*Content of dry gold ores sold or treated in Idaho in 1922.*

| County. | Ore. | Gold. | Silver. | Copper. | Lead. |
|---|---|---|---|---|---|
| | *Short tons.* | *Fine ounces.* | *Fine ounces.* | *Pounds.* | *Pounds.* |
| Ada | 57 | 43.60 | 29 | | |
| Blaine | 3 | 5.00 | 21 | 32 | 150 |
| Boise | 19,574 | 6,669.26 | 2,109 | | |
| Elmore | 34 | 29.28 | 14 | | |
| Idaho | 487 | 654.49 | 392 | | |
| Lemhi | 645 | 326.97 | 165 | | |
| Owyhee | 60 | 132.56 | 349 | 13 | |
| Valley | 720 | 873.00 | 396 | | |
| | 21,580 | 8,734.16 | 3,475 | 45 | 150 |

GOLD AND SILVER ORE.

The Princess Blue Ribbon mine, in Camas County, produced smelting ore containing gold and silver nearly equal in value. Gold and silver ore averaged $15.59 in gold and 8.96 ounces of silver to the ton, with a little copper and lead.

*Content of dry gold and silver ores sold or treated in Idaho in 1922.*

| County. | Ore. | Gold. | Silver. | Copper. | Lead. |
|---|---|---|---|---|---|
| | *Short tons.* | *Fine ounces.* | *Fine ounces.* | *Pounds.* | *Pounds.* |
| Camas | 225 | 177.70 | 2,066 | 288 | 7,693 |
| Custer | 22 | 10.91 | 134 | | |
| Owyhee | 10 | 5.20 | 104 | | |
| | 257 | 193.81 | 2,304 | 288 | 7,693 |

SILVER ORE.

Silver ore was produced principally in Shoshone, Owyhee, and Washington counties. Only a small output came from the once famous camp of Silver City, in Owyhee County. Bonner County produced much ore that was valuable for its silver, but it contained sufficient copper and lead to change its classification. The silver ore averaged $0.83 in gold and 21.79 ounces of silver to the ton, as well as a small quantity of copper and lead.

*Content of dry silver ore sold or treated in Idaho in 1922.*

| County. | Ore. | Gold. | Silver. | Copper. | Lead. |
|---|---|---|---|---|---|
| | *Short tons.* | *Fine ounces.* | *Fine ounces.* | *Pounds.* | *Pounds.* |
| Blaine | 101 | 4.68 | 1,594 | 8 | 2,530 |
| Boise | 26 | 1.14 | 376 | 13 | |
| Bonner | 78 | 4.34 | 2,303 | 150 | 495 |
| Camas | 3 | | 354 | 13 | 288 |
| Custer | 5 | 29.00 | 1,936 | 170 | 258 |
| Gem | 32 | 12.58 | 471 | | |
| Lemhi | 20 | 1.65 | 118 | 649 | 887 |
| Owyhee | 1,424 | 100.00 | 23,490 | 152 | 293 |
| Shoshone | 1,571 | 1.38 | 38,583 | 8,329 | 11,473 |
| Washington | 669 | 2.20 | 16,373 | 9,435 | 1,928 |
| | 3,929 | 156.97 | 85,598 | 18,919 | 18,152 |

### COPPER ORE.

Copper ore was mined principally in Custer and Lemhi counties, and the increase from Lemhi County was notable. No shipments were made from the St. Joe district, Shoshone County. Copper ore averaged $1.30 in gold and 1.37 ounces of silver to the ton and contained 3.95 per cent of copper.

*Content of copper ores sold or treated in Idaho in 1922.*

| County. | Ore. | Gold. | Silver. | Copper. | Lead. |
|---|---|---|---|---|---|
| | *Short tons.* | *Fine ounces.* | *Fine ounces.* | *Pounds.* | *Pounds.* |
| Bonner | 10 | 2.00 | 4,347 | 1,380 | 707 |
| Custer | 16,717 | 2,019.00 | 33,988 | 1,843,200 | ..... |
| Gem | 2 | .20 | 204 | 288 | ..... |
| Lemhi | 15,589 | 12.90 | 991 | 715,765 | ..... |
| Shoshone | 272 | 11.68 | 5,020 | 11,702 | ..... |
| | 32,590 | 2,045.78 | 44,550 | 2,572,335 | 707 |

### LEAD ORE.

Lead ore, the most valuable output of Idaho, was largely milling ore from Shoshone County. Lead ore in quantity was also mined and shipped from Blaine, Boundary, Lemhi, and Custer counties. The average content was 4.09 ounces of silver to the ton, 0.01 per cent of copper, 7.27 per cent of lead, and 0.07 per cent of zinc.

*Content of lead ore sold or treated in Idaho in 1922.*

| County. | Ore. | Gold. | Silver. | Copper. | Lead. | Recoverable zinc. |
|---|---|---|---|---|---|---|
| | *Short tons.* | *Fine ounces.* | *Fine ounces.* | *Pounds.* | *Pounds.* | *Pounds.* |
| Ada | 1 | ..... | 17 | 62 | 331 | ..... |
| Blaine | 45,387 | 843.86 | 459,869 | 27,512 | 3,592,839 | ..... |
| Boise | 380 | 121.00 | 2,571 | 97 | 37,965 | ..... |
| Bonner | 125 | .92 | 4,399 | 309 | 158,819 | ..... |
| Boundary | 35,591 | 1.63 | 60,229 | ..... | 2,880,871 | ..... |
| Butte | 63 | 1.65 | 1,790 | 177 | 38,477 | ..... |
| Camas | 150 | 46.64 | 160 | 231 | 3,434 | ..... |
| Clark | 28 | .09 | 104 | ..... | 11,923 | ..... |
| Custer | 10,710 | 46.19 | 212,338 | 44,896 | 1,895,634 | ..... |
| Lemhi | 12,181 | 435.03 | 97,639 | 4,766 | 4,433,357 | ..... |
| Shoshone | 1,227,177 | 1,093.09 | 4,610,922 | 321,110 | 180,497,655 | 1,699,261 |
| | 1,331,785 | 2,590.10 | 5,450,038 | 399,160 | 193,551,305 | 1,699,261 |

### COPPER-LEAD ORE.

Nearly all the copper-lead ore was of milling grade and contained considerable gold and silver. It averaged $1.29 in gold and 17.58 ounces of silver to the ton and contained 0.56 per cent of copper and 0.64 per cent of lead.

*Content of copper-lead ore sold or treated in Idaho in 1922.*

| County. | Ore. | Gold. | Silver. | Copper. | Lead. |
|---|---|---|---|---|---|
| | *Short tons.* | *Fine ounces.* | *Fine ounces.* | *Pounds.* | *Pounds.* |
| Bonner | 26,000 | 1,635.00 | 391,819 | 272,483 | 315,543 |
| Butte | 4 | ..... | 524 | 212 | 1,115 |
| Custer | 139 | ..... | 67,186 | 19,400 | 16,387 |
| | 26,143 | 1,635.00 | 459,529 | 292,095 | 333,045 |

### ZINC ORE AND LEAD-ZINC ORE.

Only a few lots of zinc ore were marketed in 1922. The lead-zinc ore, all from Shoshone County, was milled and averaged 1.68 ounces of silver to the ton, 4.69 per cent of lead, and 5.77 per cent of zinc.

## GOLD.

The mine production of gold in Idaho in 1922 showed a decrease of 8 per cent. The average yearly output in the last 10 years has been about $850,000, but the output has decreased decidedly in the last 5 years. Boise County had the largest output of gold, and Shoshone County was second, on account of dredge operations near Murray. The lode mines produced $317,433 in gold, and the placers $183,972, of which $158,827 was won by dredges. Though many of the deep mines were idle, gold from copper-lead ore increased in Bonner County, and new dredge operations in Elmore County suggest a large output of gold from placers at Featherville. Of the total gold, 37 per cent came from placers, 37 per cent from dry and siliceous ore, 8 per cent from copper ore, 11 per cent from lead ore, and 7 per cent from copper-lead ore. The production of gold from mills using amalgamation and cyanidation decreased to 8,643.85 ounces, but this was nearly 36 per cent of the total. Concentrates of all kinds contained 15 per cent of the total gold, and crude ore shipped to smelters contained 13 per cent of the total. Since 1897 a total of $4,598,387 in gold has been recovered by dredges.

In 1922 only five mines had a gold output of more than $25,000 each—those of the Gold Hill & Iowa Mines Co., at Quartzburg; the Yukon Gold Co., at Murray; the Idaho Metals Co., at Mackay; the Talache mine, at Talache; and the South Park Dredging Co., in Elmore County.

## SILVER.

The mine production of silver in Idaho increased only 1,337 ounces. Decreases in Shoshone, Blaine, and Custer counties were balanced by increases in Bonner, Lemhi, and Boundary counties. A separation of the silver according to source shows that 90 per cent of the total silver yield was from lead ore, 8 per cent from copper-lead ore, and 2 per cent from other sources. Shoshone County produced 77 per cent of the silver. Concentrates contained more than 72 per cent of the silver, shipping ore more than 27 per cent, and placer bullion and gold and silver bullion from deep mines less than 1 per cent.

Eight mines in Idaho produced nearly 83 per cent of the total silver in 1922. They were the Bunker Hill, Hecla, Morning, Independence, Talache, Hercules, Gold Hunter, and Ramshorn mines. Each of these produced more than 200,000 ounces of silver, and two of them produced more than 1,000,000 ounces each.

## COPPER.

The mine production of copper in Idaho in 1922 was nearly double that of 1921. The largest increases were in Custer, Lemhi, and Bonner counties. No shipments of importance were made from copper

mines in Shoshone County. The Idaho Metals property (formerly the Empire), near Mackay, Custer County, was the largest producer of copper in the State, and the Harmony, Talache, and Pope Shenon mines also produced ore containing copper. More than 78 per cent of the total output was from copper ore, 12 per cent from lead ore, and 9 per cent from copper-lead ore. Crude shipping ore of all kinds contained 61 per cent of the copper, and concentrates 39 per cent.

### LEAD.

The mine production of lead in Idaho in 1922 decreased about 1 per cent in quantity but increased nearly 21 per cent in value. Shoshone County supplied 93 per cent of the total output, but a good production was made in Lemhi, Blaine, Boundary, and Custer counties. Nearly all the lead (99 per cent) came from lead ore. Concentrates of all kinds produced 79 per cent of the total, and crude ore shipped was the source of 21 per cent.

Fourteen mines produced more than 1,000,000 pounds of lead each in 1922, and three of them—the Bunker Hill, Morning, and Hecla—produced more than 40,000,000 pounds each. Other large producers were the Hercules, Tamarack & Custer, Independence, Latest Out, Idaho Continental, Callahan, Sierra Nevada, Gold Hunter, Pittsburgh-Idaho, Hayes, and Mace.

### ZINC.

The output of recoverable zinc was 4,109,131 pounds, most of which was contained in concentrate from Shoshone County. As the price of zinc increased late in the year, the Morning and Callahan mines marketed several thousand tons of concentrate. Other mines, such as the Success, in the Placer Center district, held zinc ore and concentrate for a better market.

### MINING INDUSTRY.

The mining industry of Idaho was in a fairly prosperous condition in 1922, though several large mines were idle a large part of the year. Metal prices increased steadily and were especially high late in the year. The Bunker Hill, Hecla, and Morning mines kept up steady shipments at the rate of about 14,000 tons of ore and concentrate a month and proved to be the backbone of the silver-lead industry of the State. On the other hand, the normal output was decidedly curtailed by the idleness of the Tamarack & Custer and Hercules mines until July, after which their output was comparatively small until December. The increase in the price of zinc gave a decided impetus to the marketing of zinc concentrates from the Callahan and Morning mines, which was resumed in October, after a long period of idleness. Operators complained of a shortage of labor throughout the year, but the condition was not acute during the last quarter, when miners' wages were increased to $5 a day.

## METALLURGIC INDUSTRY.

In Idaho 45 milling plants of all kinds were in operation in 1922, against 39 in 1921. Of these mills 31 were concentration plants, 13 of which used flotation machines with other concentrating devices, 4 used flotation alone, and 14 used crushers, jigs, and tables without flotation cells; 11 used amalgamation alone; 1 used cyanidation; and 2 used amalgamation and cyanidation. A complete list of mills in Idaho giving the process and equipment of each for 1920 is given in a bulletin prepared by the Geological Survey and published by the Bureau of Mines.

Less than 2 per cent of the ore was treated in gold and silver mills in 1922. Bullion from this ore treated by amalgamation and cyanidation was valued at $183,034, or $8.45 a ton, a decrease in the quantity of bullion but an increase in the value per ton. Most of the gold in bullion was won by amalgamation, and 411 pounds of quicksilver, 4,701 pounds of sodium cyanide, and 800 pounds of potassium cyanide were used at these mills in 1922. The average quicksilver purchased was 0.019 pound per ton of ore amalgamated and 0.042 pound per ounce of gold and silver bullion saved. The consumption of cyanide was 1.68 pounds per ounce of gold and silver bullion recovered.

*Gold and silver produced in mills in Idaho in 1922, by counties.*

| County. | Ore (short tons). | Bullion (fine ounces) recovered from ore by— | | | | Total value. |
|---|---|---|---|---|---|---|
| | | Amalgamation. | | Cyanidation. | | |
| | | Gold. | Silver. | Gold. | Silver. | |
| Ada | 57 | 43.60 | 29 | | | $930 |
| Blaine | 60 | | | 3.98 | 786 | 868 |
| Boise | 19,599 | 5,523.74 | 1,397 | 1,146.66 | 966 | 140,252 |
| Custer | 22 | | | 10.91 | 134 | 360 |
| Elmore | 34 | 1.94 | | 27.34 | 14 | 619 |
| Idaho | 487 | 654.50 | 392 | | | 13,922 |
| Lemhi | 623 | 140.42 | 22 | 144.00 | 56 | 5,957 |
| Owyhee | 60 | 73.76 | 158 | | | 1,683 |
| Valley | 720 | 873.00 | 396 | | | 18,443 |
| | 21,662 | 7,310.96 | 2,394 | 1,332.89 | 1,956 | 183,034 |

More than 87 per cent of the ore was concentrated. Concentrates from this ore, from 69,836 tons of old tailings treated, and from ore treated in gold and silver mills aggregated 194,075 tons and were valued at $69.16 a ton, against $59.91 in 1921. The concentrates came largely from the Coeur d'Alene region, and the ratio was 6.61 tons of ore and tailings to 1 ton of concentrate. Nearly all the total was lead concentrate. Operators in Shoshone County shipped an average of 14,974 tons of concentrates of various kinds a month, against 15,973 tons in 1921. This with the crude ore shipped, which was 5,205 tons a month, gives the Coeur d'Alene region an average monthly output of 20,179 tons of concentrates and crude ore a month, against 20,330 tons in 1921. The average metal content of the lead concentrate was about the same as that of 1921, but the average value increased from $58.66 to $68 a ton.

*Mine production of metals from Idaho concentrates in 1922.*

**By counties.**

| County. | Ore to concentrating mills. | Concentrates. | Gold. | Silver. | Copper. | Lead. | Recoverable zinc. | Total value of concentrates. |
|---|---|---|---|---|---|---|---|---|
| | *Short tons.* | *Short tons.* | *Fine ounces.* | *Fine ounces.* | *Pounds.* | *Pounds.* | *Pounds.* | |
| Blaine | 44,624 | 5,396 | 731.48 | 372,517 | 22,686 | 2,951,921 | ..... | $553,057 |
| Boise | 364 | 91 | 120.00 | 1,552 | ..... | 33,527 | ..... | 5,877 |
| Bonner | 26,000 | 2,577 | 1,635.00 | 391,819 | 272,483 | 315,543 | ..... | 479,757 |
| Boundary | 35,500 | 2,373 | 1.63 | 58,468 | ..... | 2,792,040 | ..... | 212,064 |
| Camas | 150 | 21 | 46.64 | 160 | 231 | 3,434 | ..... | 1,344 |
| Custer | 8,732 | 1,690 | 22.40 | 186,613 | 40,643 | 1,251,458 | ..... | 261,393 |
| Lemhi | 20,086 | 2,109 | 40.53 | 11,126 | 699,471 | 369,210 | ..... | 126,700 |
| Owyhee | 1,428 | 15 | 103.00 | 22,669 | 152 | 293 | ..... | 24,834 |
| Shoshone | 1,117,232 | 179,692 | 839.78 | 3,373,277 | 244,364 | 147,208,245 | 4,065,810 | 11,751,830 |
| Washington | 450 | 111 | 2.20 | 5,516 | 3,703 | ..... | ..... | 6,061 |
| | 1,254,566 | 194,075 | 3,542.66 | 4,423,717 | 1,283,733 | 154,925,671 | 4,065,810 | 13,422,917 |

**By kinds of concentrates.**

| Kind. | Concentrates. | Gold. | Silver. | Copper. | Lead. | Recoverable zinc. | Total value of concentrates. |
|---|---|---|---|---|---|---|---|
| | *Short tons.* | *Fine ounces.* | *Fine ounces.* | *Pounds.* | *Pounds.* | *Pounds.* | |
| Dry and siliceous | 378 | 105.30 | 39,229 | 9,523 | 355 | ..... | $42,711 |
| Copper | 1,566 | 23.33 | 2,820 | 708,291 | ..... | ..... | 98,921 |
| Lead | 184,643 | 1,779.03 | 3,984,914 | 293,436 | 154,457,858 | ..... | 12,556,486 |
| Zinc | 4,911 | ..... | 4,935 | ..... | 151,915 | 4,065,810 | 245,041 |
| Copper-lead | 2,577 | 1,635.00 | 391,819 | 272,483 | 315,543 | ..... | 479,758 |

**Average content.**

| Kind of concentrates. | Concentrates. | Gold. | Silver. | Copper. | Lead. | Recoverablezinc. | Total value. |
|---|---|---|---|---|---|---|---|
| | *Short tons.* | *Fine ounces per ton.* | *Fine ounces per ton.* | *Per cent.* | *Per cent.* | *Per cent.* | |
| Dry and siliceous | 378 | 0.28 | 103.78 | 1.26 | 0.05 | ..... | $112.99 |
| Copper | 1,566 | .01 | 1.80 | 22.61 | ..... | ..... | 63.17 |
| Lead | 184,643 | .01 | 21.58 | .08 | 41.83 | ..... | 68.00 |
| Zinc | 4,911 | ..... | 1.00 | ..... | 1.55 | 41.39 | 49.90 |
| Copper-lead | 2,577 | .63 | 152.04 | 5.29 | 6.12 | ..... | 186.17 |
| | 194,075 | .02 | 22.79 | .33 | 39.91 | 1.05 | 69.16 |

Of the total ore 6 per cent was shipped crude to smelters, and most of it with the concentrates was treated at East Helena, Mont.; Bradley, Idaho; and Vallejo, Calif. The total value of the first-class ore was $4,239,673, against $3,218,206 in 1921. Nearly 80 per cent of the crude ore shipped was lead ore, and 19 per cent was copper ore. Most of the ore smelted was sulphide. The combined value of the concentrates and crude ore shipped was $17,662,590.

*Mine production of metals from Idaho crude ore shipped to smelters in 1922.*

**By counties.**

| County. | Ore. | Gold. | Silver. | Copper. | Lead. | Recoverable zinc. | Total value. |
|---|---|---|---|---|---|---|---|
| | *Short tons.* | *Fine ounces.* | *Fine ounces.* | *Pounds.* | *Pounds.* | *Pounds.* | |
| Ada | 1 | ..... | 17 | 62 | 331 | ..... | $43 |
| Adams | 45 | ..... | ..... | ..... | ..... | 25,200 | 1,436 |
| Blaine | 846 | 118.08 | 88,181 | 4,866 | 643,598 | 18,121 | 127,710 |
| Boise | 17 | 1.00 | 1,141 | 110 | 4,438 | ..... | 1,421 |
| Bonner | 213 | 7.26 | 11,049 | 1,839 | 160,021 | ..... | 20,248 |
| Boundary | 91 | ..... | 1,761 | ..... | 88,831 | ..... | 6,647 |
| Butte | 67 | 1.65 | 2,314 | 389 | 39,592 | ..... | 4,579 |
| Camas | 228 | 177.70 | 2,420 | 301 | 7,981 | ..... | 6,573 |
| Clark | 20 | .09 | 104 | ..... | 11,923 | ..... | 762 |
| Custer | 18,839 | 2,071.79 | 128,835 | 1,867,023 | 660,821 | ..... | 460,056 |
| Gem | 34 | 12.78 | 675 | 288 | ..... | ..... | 978 |
| Lemhi | 7,726 | 451.60 | 87,709 | 21,709 | 4,065,034 | ..... | 323,550 |
| Owyhee | 6 | 61.00 | 1,116 | 13 | ..... | ..... | 2,379 |
| Shoshone | 62,468 | 266.38 | 1,315,660 | 96,777 | 35,224,036 | ..... | 3,271,554 |
| Washington | 219 | ..... | 10,857 | 5,732 | 1,928 | ..... | 11,737 |
| | 90,820 | 3,169.33 | 1,651,839 | 1,999,109 | 40,908,534 | 43,321 | 4,239,673 |

**By kinds of ore.**

| | | | | | | | |
|---|---|---|---|---|---|---|---|
| Dry and siliceous | 1,218 | 335.81 | 47,798 | 9,729 | 25,640 | ..... | $57,463 |
| Copper | 16,814 | 2,022.45 | 41,730 | 1,864,044 | 707 | ..... | 335,223 |
| Lead | 72,561 | 811.07 | 1,494,601 | 105,724 | 40,864,685 | ..... | 3,773,198 |
| Zinc | 84 | ..... | ..... | ..... | ..... | 43,321 | 2,469 |
| Copper-lead | 143 | ..... | 67,710 | 19,612 | 17,502 | ..... | 71,320 |

**Average content.**

| Kind of ore. | Ore. | Gold. | Silver. | Copper. | Lead. | Recoverable zinc. | Total value. |
|---|---|---|---|---|---|---|---|
| | *Short tons.* | *Fine ounces per ton.* | *Fine ounces per ton.* | *Per cent.* | *Per cent.* | *Per cent.* | |
| Dry and siliceous | 1,218 | 0.27 | 39.24 | 0.40 | 1.05 | ..... | $47.18 |
| Copper: | | | | | | | |
| Oxidized | 2,506 | .12 | 2.00 | 5.51 | ..... | ..... | 19.36 |
| Sulphide | 14,308 | .12 | 2.57 | 5.55 | ..... | ..... | 20.04 |
| Lead: | | | | | | | |
| Oxidized | 12,709 | .03 | 14.15 | .11 | 20.52 | ..... | 37.72 |
| Sulphide | 59,852 | .01 | 21.97 | .07 | 29.78 | ..... | 55.03 |
| Zinc: | | | | | | | |
| Oxidized | 84 | ..... | ..... | ..... | ..... | 25.79 | 29.39 |
| Copper-lead: | | | | | | | |
| Oxidized | 4 | ..... | 131.00 | 2.65 | 13.94 | ..... | 153.50 |
| Sulphide | 139 | ..... | 483.35 | 6.98 | 5.89 | ..... | 508.68 |
| | 90,820 | .03 | 18.19 | 1.10 | 22.52 | .02 | 46.68 |

# PRODUCTION BY COUNTIES.

## GENERAL FEATURES.

*Mine production of gold, silver, copper, lead, and zinc in Idaho in 1922.*

| County. | Gold. | | | | | Silver. | |
|---|---|---|---|---|---|---|---|
| | Placers. | | Deep mines. | | Total value. | Fine ounces. | Value. |
| | Fine ounces. | Value. | Fine ounces. | Value. | | | |
| Ada | 15.96 | $330 | 43.59 | $901 | $1,231 | 49 | $49 |
| Adams | | | | | | | |
| Bingham | 1.35 | 28 | | | 28 | | |
| Blaine | | | 853.53 | 17,644 | 17,644 | 461,484 | 461,484 |
| Boise | 406.01 | 8,393 | 6,791.42 | 140,391 | 148,784 | 5,153 | 5,153 |
| Bonner | | | 1,642.23 | 33,948 | 33,948 | 402,868 | 402,868 |
| Bonneville | 4.69 | 97 | | | 97 | | |
| Boundary | | | 1.64 | 34 | 34 | 60,229 | 60,229 |
| Butte | | | 1.64 | 34 | 34 | 2,314 | 2,314 |
| Camas | 7.50 | 155 | 224.36 | 4,638 | 4,793 | 2,582 | 2,582 |
| Clark | | | .10 | 2 | 2 | 104 | 104 |
| Clearwater | 293.05 | 6,058 | | | 6,058 | 73 | 73 |
| Custer | 51.90 | 1,073 | 2,105.09 | 43,516 | 44,589 | 315,600 | 315,600 |
| Elmore | 1,495.36 | 30,912 | 29.27 | 605 | 31,517 | 531 | 531 |
| Gem | 8.47 | 175 | 12.77 | 264 | 439 | 679 | 679 |
| Gooding | 1.26 | 26 | | | 26 | | |
| Idaho | 363.40 | 7,512 | 654.51 | 13,530 | 21,042 | 454 | 454 |
| Jerome | 4.02 | 83 | | | 83 | | |
| Kootenai | 1.74 | 36 | | | 36 | | |
| Latah | 53.99 | 1,116 | | | 1,116 | 3 | 3 |
| Lemhi | 170.71 | 3,529 | 776.57 | 16,053 | 19,582 | 98,927 | 98,927 |
| Owyhee | 4.60 | 95 | 237.76 | 4,915 | 5,010 | 23,943 | 23,943 |
| Power | 7.50 | 155 | | | 155 | | |
| Shoshone | 5,950.08 | 122,999 | 1,106.14 | 22,866 | 145,865 | 4,690,097 | 4,690,097 |
| Twin Falls | 34.15 | 706 | | | 706 | 2 | 2 |
| Valley | 17.95 | 371 | 873.02 | 18,047 | 18,418 | 399 | 399 |
| Washington | 5.95 | 123 | 2.18 | 45 | 168 | 16,374 | 16,374 |
| | 8,899.64 | 183,972 | 15,355.82 | 317,433 | 501,405 | 6,081,865 | 6,081,865 |

| County. | Copper. | | Lead. | | Recoverable zinc. | | Total value. |
|---|---|---|---|---|---|---|---|
| | Pounds. | Value. | Pounds. | Value. | Pounds. | Value. | |
| Ada | 62 | $8 | 331 | $18 | | | $1,306 |
| Adams | | | | | 25,200 | $1,436 | 1,436 |
| Bingham | | | | | | | 28 |
| Blaine | 27,552 | 3,720 | 3,595,519 | 197,754 | 18,121 | 1,033 | 681,635 |
| Boise | 110 | 15 | 37,965 | 2,088 | | | 156,040 |
| Bonner | 274,322 | 37,033 | 475,564 | 26,156 | | | 500,005 |
| Bonneville | | | | | | | 97 |
| Boundary | | | 2,880,871 | 158,448 | | | 218,711 |
| Butte | 389 | 53 | 39,592 | 2,178 | | | 4,579 |
| Camas | 532 | 72 | 11,415 | 628 | | | 8,075 |
| Clark | | | 11,923 | 656 | | | 762 |
| Clearwater | | | | | | | 6,131 |
| Custer | 1,907,666 | 257,535 | 1,912,279 | 105,175 | | | 722,899 |
| Elmore | | | | | | | 32,048 |
| Gem | 288 | 39 | | | | | 1,157 |
| Gooding | | | | | | | 26 |
| Idaho | | | | | | | 21,496 |
| Jerome | | | | | | | 83 |
| Kootenai | | | | | | | 36 |
| Latah | | | | | | | 1,119 |
| Lemhi | 721,180 | 97,359 | 4,434,244 | 243,883 | | | 459,751 |
| Owyhee | 165 | 22 | 293 | 16 | | | 28,991 |
| Power | | | | | | | 155 |
| Shoshone | 341,141 | 46,054 | 182,432,281 | 10,033,775 | 4,065,810 | 231,751 | 15,147,542 |
| Twin Falls | | | | | | | 708 |
| Valley | | | | | | | 18,817 |
| Washington | 9,435 | 1,274 | 1,928 | 106 | | | 17,922 |
| | 3,282,842 | 443,184 | 195,834,205 | 10,770,881 | 4,109,131 | 234,220 | 18,031,555 |

*Producing placer mines and production of gold and silver in Idaho in 1921 and 1922.*

| County. | 1921 | | | | | | 1922 | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | Mines. | | | Gold. | Silver (fine ounces). | Total value. | Mines. | | | Gold. | Silver (fine ounces). | Total value. |
| | Hydraulic. | Dredge. | Drift. | | | | Hydraulic. | Dredge. | Drift. | | | |
| Ada | 3 | ..... | ..... | $423 | 8 | $431 | 3 | ..... | 1 | $330 | 3 | $333 |
| Bingham | 1 | ..... | ..... | 497 | 2 | 499 | 1 | ..... | ..... | 28 | ..... | 28 |
| Boise | 15 | ..... | ..... | 10,625 | 131 | 10,756 | 13 | ..... | 2 | 8,393 | 97 | 8,490 |
| Bonneville | 4 | 1 | ..... | 2,294 | 4 | 2,298 | 1 | ..... | ..... | 97 | ..... | 97 |
| Camas | 1 | ..... | ..... | 62 | ..... | 62 | 1 | ..... | ..... | 155 | 2 | 157 |
| Canyon | 1 | ..... | ..... | 50 | ..... | 50 | ..... | ..... | ..... | ..... | ..... | ..... |
| Clearwater | 6 | 1 | ..... | 3,547 | 43 | 3,590 | 5 | 1 | ..... | 6,058 | 73 | 6,131 |
| Custer | 4 | ..... | ..... | 1,480 | 16 | 1,496 | 4 | ..... | ..... | 1,073 | 18 | 1,091 |
| Elmore | 4 | ..... | ..... | 448 | 8 | 456 | 2 | 1 | ..... | 30,912 | 517 | 31,429 |
| Gem | ..... | ..... | ..... | ..... | ..... | ..... | 1 | ..... | ..... | 175 | 4 | 179 |
| Gooding | ..... | ..... | ..... | ..... | ..... | ..... | 1 | ..... | ..... | 26 | ..... | 26 |
| Idaho | 28 | ..... | 1 | 9,267 | 85 | 9,352 | 24 | ..... | ..... | 7,512 | 62 | 7,574 |
| Jerome | 1 | ..... | ..... | 135 | ..... | 135 | 1 | ..... | ..... | 83 | ..... | 83 |
| Kootenai | ..... | ..... | ..... | ..... | ..... | ..... | 1 | ..... | ..... | 36 | ..... | 36 |
| Latah | 4 | ..... | ..... | 521 | 2 | 523 | 4 | ..... | ..... | 1,116 | 3 | 1,119 |
| Lemhi | 4 | ..... | ..... | 1,780 | 8 | 1,788 | 11 | ..... | ..... | 3,529 | 14 | 3,543 |
| Owyhee | 3 | ..... | ..... | 150 | 2 | 152 | 2 | ..... | ..... | 95 | ..... | 95 |
| Power | 1 | ..... | ..... | 130 | 1 | 131 | 1 | ..... | ..... | 155 | ..... | 155 |
| Shoshone | 3 | 1 | ..... | 148,878 | 1,342 | 150,220 | 2 | 1 | 2 | 122,999 | 1,160 | 124,159 |
| Twin Falls | 2 | ..... | ..... | 172 | ..... | 172 | 2 | ..... | ..... | 706 | 2 | 708 |
| Valley | 3 | ..... | ..... | 1,141 | 34 | 1,175 | 5 | ..... | ..... | 371 | 3 | 374 |
| Washington | ..... | ..... | ..... | ..... | ..... | ..... | 1 | ..... | ..... | 123 | 1 | 124 |
| | 88 | 3 | 1 | 181,600 | 1,686 | 183,286 | 86 | 3 | 5 | 183,972 | 1,959 | 185,931 |

*Ore sold or treated, deep mines producing, and average value of ores in Idaho in 1921 and 1922, by counties.*

| County. | Ore sold or treated in 1922 (short tons). | | Number of deep mines producing. | | Average total value per ton. | | Average value per ton in gold and silver. | |
|---|---|---|---|---|---|---|---|---|
| | Total. | Increase or decrease. | 1921 | 1922 | 1921 | 1922 | 1921 | 1922 |
| Ada | 58 | +58 | ..... | 3 | ..... | $16.78 | ..... | $16.33 |
| Adams | 45 | +45 | ..... | 1 | ..... | 31.91 | ..... | ..... |
| Blaine | 45,530 | +4,832 | 20 | 24 | $20.68 | 14.97 | $15.12 | 10.52 |
| Boise | 19,980 | −23,591 | 10 | 12 | 5.77 | 7.38 | 5.76 | 7.28 |
| Bonner | 26,213 | +26,054 | 4 | 5 | 57.82 | 19.07 | 53.84 | 16.66 |
| Boundary | 35,591 | +23,417 | 2 | 1 | 7.92 | 6.15 | 2.36 | 1.69 |
| Butte | 67 | −253 | 4 | 4 | 11.13 | 68.34 | 2.76 | 35.04 |
| Camas | 378 | +294 | 4 | 3 | 33.11 | 20.95 | 30.11 | 19.10 |
| Clark | 20 | −5 | 1 | 2 | 44.32 | 38.10 | .84 | 5.30 |
| Custer | 27,593 | +3,997 | 14 | 13 | 24.99 | 26.16 | 16.82 | 13.01 |
| Elmore | 34 | −78 | 6 | 2 | 26.54 | 18.21 | 24.83 | 18.21 |
| Gem | 34 | +34 | ..... | 2 | ..... | 28.76 | ..... | 27.62 |
| Idaho | 487 | −113 | 2 | 9 | 18.45 | 28.59 | 18.45 | 28.59 |
| Lemhi | 28,435 | +15,275 | 23 | 22 | 13.59 | 16.04 | 6.31 | 4.04 |
| Owyhee | 1,494 | +936 | 9 | 11 | 41.80 | 19.34 | 41.80 | 19.31 |
| Shoshone | 1,249,536 | −129,642 | 31 | 36 | 9.84 | 12.02 | 3.63 | 3.77 |
| Valley | 720 | +690 | 1 | 1 | 15.63 | 25.61 | 15.63 | 25.61 |
| Washington | 669 | +487 | 2 | 3 | 58.68 | 26.60 | 56.24 | 24.54 |
| | 1,436,884 | −77,563 | 133 | 154 | 10.30 | 12.42 | 4.25 | 4.45 |

## ADA COUNTY.

*Black Hornet district.*—Gold ore was mined and treated by amalgamation from the Maynard property, which consists of three claims.

*Highland district.*—Four small placers in the Highland district produced $330 in gold and 3 ounces of silver. The Charcoal placer, on the old gravel bed of Boise River, was operated by sluicing.

## ADAMS COUNTY.

*Seven Devils district.*—The Azurite Mining Co. installed a concentration-flotation plant in 1922 in which preliminary testing was done. Two lots of zinc ore were shipped to the Great Western Electrochemical Co.'s plant at Pittsburg, Calif. The Idaho Copper Co. continued to develop the Red Ledge property, which is said to contain considerable low-grade copper ore.

## BLAINE COUNTY.

*Mine production of gold, silver, copper, lead, and zinc in Blaine County, Idaho, in 1921 and 1922.*

| Year. | Number of producers. | Ore. | Gold. | Silver. | Copper. | Lead. | Recoverable zinc. | Total value. |
|---|---|---|---|---|---|---|---|---|
| | | *Short tons.* | | *Fine ounces.* | *Pounds.* | *Pounds.* | *Pounds.* | |
| 1921 | 20 | 40,698 | $23,552 | 591,929 | 35,834 | 4,925,416 | ..... | $841,748 |
| 1922 | 24 | 45,530 | 17,644 | 461,484 | 27,552 | 3,595,519 | 18,121 | 681,635 |
| Increase or decrease, 1922 | +4 | +4,832 | −5,908 | −130,445 | −8,282 | −1,329,897 | +18,121 | −160,113 |
| Total, 1880–1922 | ..... | ..... | 2,546,522 | 17,414,528 | 345,381 | 196,690,116 | 8,015,211 | 27,914,523 |

From 1880 to 1922 Blaine County has produced $2,546,522 in gold, $15,977,008 in silver, $61,148 in copper, $8,680,263 in lead, and $649,582 in zinc. Though the value of the output decreased in 1922, much interest was shown in development work in the Mineral Hill and Warm Springs districts.

*Gold Belt district.*—One shipment of siliceous silver ore was made from the Glengarill mine, about 10 miles southwest of Hailey.

*Mineral Hill district (Hailey).*—Fourteen mines in the Mineral Hill district produced 540 tons of ore, containing $449 in gold, 11,399 ounces of silver, 1,043 pounds of copper, and 78,385 pounds of lead, valued in all at $16,300, or $30.19 a ton. Of this ore 300 tons was concentrated and 180 tons was shipped directly to smelters. Part of the mill ore came from the dump of the Minnie Moore property. Several lots of rich silver-lead ore were shipped by the Utah Bellevue Mining Co.; the remainder was made up of small shipments from the Plata Corporation, Colorado, Daisy, Eureka, Hard Times, Hope, La Grande, Lark, and Little Joint properties. Prospecting was continued at the Bullion & Mayflower property by the Bunker Hill & Sullivan Mining & Concentrating Co.

*Warm Springs district (Ketchum).*—Eight deep mines in the Warm Springs district produced 44,970 tons of ore, containing

$17,188 in gold, 449,386 ounces of silver, 26,491 pounds of copper, 3,516,268 pounds of lead, and 18,121 pounds of zinc, valued in all at $664,578, or $14.78 a ton. The largest producers were the Independence and Golden Glow mines; smaller lots were shipped from the Homestake, Smith & Price, Wild Cat, Idaho Germania, and White Elephant mines. The Independence mine was operated the entire year by the Federal Mining & Smelting Co. and was the largest producer of lead in the county. The ore, which contains galena, chalcopyrite, tetrahedrite, siderite, jamesonite, and sphalerite, is dropped down a 530-foot inclined raise and hauled by electricity 6,600 feet through the Plumber tunnel to the tramway and the mill. During the year 44,748 tons of ore was extracted which averaged 0.036 ounce of gold and 16 ounces of silver to the ton and contained 5.9 per cent of lead. The net profit was $96.932, a decrease from that of 1921. The printed report of the operating company[2] says:

> The Independence mine has been somewhat disappointing. The ore is of excellent grade, carrying about 2½ ounces of silver per ton for each unit of lead, but its occurrence is very irregular, and we have found the east end of the mine to be much faulted and broken up, and the ore shoots are smaller and more irregular than ever. * * *
>
> The silver output being an important factor, the earnings of this mine will be * * * seriously affected by the termination of the Pittman Act.

The Consolidated Mascot Mines Co. employed 50 men in development work and did much work in equipping the camp. The property is opened by about 4,000 feet of tunnels and drifts. The Homestake mine, a regular producer, was acquired by the Mineral Exploration Co., which plans extensive development work.

*Wood River district.*—One test lot of lead ore was shipped from the Tigee property.

## BOISE COUNTY.

*Mine production of gold, silver, copper, and lead in Boise County, Idaho, in 1921 and 1922.*

| Year. | Number of producers. | Ore. | Gold.[a] | Silver.[a] | Copper. | Lead. | Total value. |
|---|---|---|---|---|---|---|---|
| | | *Short tons.* | | *Fine ounces.* | *Pounds.* | *Pounds.* | |
| 1921 | 25 | 43,571 | $256,094 | 5,678 | ..... | 5,044 | $261.999 |
| 1922 | 27 | 19,980 | 148,784 | 5,153 | 110 | 37,965 | 156,040 |
| Increase or decrease, 1922 | +2 | −23,591 | −107,310 | −525 | +110 | +32,921 | −105,959 |
| Total, 1863–1922 | ..... | ..... | 53,418,255 | 2,215,941 | (b) | (b) | (b) |

[a] Includes placer production.
[b] Figures not available.

The output of the largest producer of gold in Boise County was only about half that of 1921, a decrease which accounts for the marked decrease in gold shown in the accompanying table.

*Banner district.*—The Idaho Development Co., operating the Edna mine, shipped a small amount of bullion from the operation of a 50-ton plant equipped for cyanidation.

[2] Federal Mining & Smelting Co. Ann Rept. for year ending Dec. 31, 1922.

*Boise Basin district (Placerville, Quartzburg, Idaho City).*—Nine deep mines and 15 placers in the Boise Basin district produced 19,948 tons of ore, $148,675 in gold, 4,775 ounces of silver, 97 pounds of copper, and 37,965 pounds of lead, valued in all at $155,551. The ore was valued at $7.37 a ton. The deep mines produced gold valued at $140, 282 and 4,678 ounces of silver, as well as the copper and lead mentioned above. The placer output consisted of gold valued at $8,393 and 97 ounces of silver. The Gold Hill & Iowa Mines Co. treated about 20,000 tons of ore by amalgamation, concentration, and cyanidation and made the largest production of gold in the State. The mine is opened by a vertical shaft 600 feet deep, and the ore occurs in rhyolite. The shaft was sunk an additional 100 feet during the year, and the mill was active 280 days, but the output was considerably less than in 1921. An interesting article[3] describing the mine and mill was published in September. At the Enterprise mine several lots of lead concentrate were produced as a result of test milling operations. Smaller producers were the J. S., Native Missourian, Hay Fork, and Boulder mines. Steady development by a large force of men was continued by the Idawa Mining Co., operating the Belshazzar mine. Large placer producers were the Crevice Diggings, Gold Eagle, and Curry Ditch properties. No dredging was done in the district in 1922.

*Summit Flat district.*—Several ounces of gold was produced at the Tip Top property.

### BONNER COUNTY.

*Lakeview district.*—The Lakeview Mining & Milling Co., operating the Weber mine, shipped several cars of rich silver ore.

*Pend d'Oreille district.*—Four deep mines in the Pend d'Oreille district produced 26,135 tons of ore, containing $33,859 in gold, 400,565 ounces of silver, 274,172 pounds of copper, and 475,069 pounds of lead, valued in all at $497,566, or $19.04 a ton. Most of the output came from the Talache property, on which a recently constructed flotation plant was operated on copper-lead ore containing considerable silver. Concentrate was shipped to Tacoma, Wash., and East Helena, Mont. The mine was the fourth largest silver producer in Idaho, and the mill was treating 160 tons a day in November. The mill feed is said to average 0.06 ounce of gold and 17 ounces of silver to the ton, with a little copper and lead. An article[4] describing the mine and mill was published in September. Lead ore was shipped from the Blue Bird, Mimetite, and Lawrence properties.

### BONNEVILLE COUNTY.

*Mount Pisgah district.*—Exceptionally rich placer gold was shipped from the Clemmens Bar property, near Gray. The Caribou Placer Mines Co. installed extensive equipment preparatory to hydraulic work on a large scale. The necessary pipe line, sluices, and clean-up plant have been completed.

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[3] McDermid, A. J., Ore deposits of Gold Hill mine, Quartzburg, Idaho: Eng. and Min. Jour.-Press, vol. 114, p. 537, Sept. 23, 1922.

[4] Wormser, F. E., Silver mining and milling at Talache, Idaho: Eng. and Min. Jour.-Press, vol. 114, p. 581, Sept. 30, 1922.

### BOUNDARY COUNTY.

*Moyie Yahk district.*—The Idaho Gold & Ruby Co. was said to have started hydraulic operations in December, but no output was reported. The company has the largest plant for such work in the State. Details regarding the equipment of this mine and other property in the State are given in the report of the State mine inspector.[5] Progress was made in the construction of a cyanidation mill by the Cyanide Gold Mining Co.

*Port Hill district* (*Klockmann*).—The Idaho Continental Co., through lessees, operated its property from May 1 to December 31 and shipped several thousand tons of high-grade lead concentrate to the Bunker Hill smelter at Bradley. The ore occurs as a replacement deposit in quartzite, and the company is said to have a large quantity of silver-lead ore in reserve. The mine is the largest producer of lead north of the Coeur d'Alene region, but transportation difficulties prevent a greater output, as the mine is 26 miles from the shipping point at Port Hill.

### BUTTE COUNTY.

*Antelope district.*—One lot of oxidized lead ore was shipped from the Lead Belt mine.

*Dome district.*—The Wilbert Mining Co., an old producer of lead ore in the Dome district, did considerable development work in driving a lower tunnel which will open the ore body at depth.

*Hamilton district.*—A test shipment of copper-lead ore containing considerable silver was made from the Ingersoll property, in the Little Lost River Mountains.

*Lava Creek district.*—Several lots of lead ore were shipped from the Creek and St. Louis properties, near Arco.

### CAMAS COUNTY.

*Beaver Creek or Camas district.*—Several hundred tons of ore containing considerable gold and silver were shipped from the Princess Blue Ribbon property, near Blaine.

*Little Smoky district.*—At the Walton mine, 13 miles northwest of Fairfield, lead ore containing gold and silver was concentrated. The mill was operated only a short time, as the company was in financial difficulties. A test shipment of rich silver ore was made from the Manchuria claim, and the Axalotl placer, on Bear Creek, produced a small quantity of gold.

### CLARK COUNTY.

*Birch Creek district.*—Several small lots of oxidized lead ore were shipped from the Birch Creek and Metta mines, west of Dubois.

### CLEARWATER COUNTY.

*Moose Creek district.*—Placer bullion was marketed from the Dodo property, on Independence Creek.

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[5] Campbell, Stewart, Twenty-fourth Ann. Rept. of the mining industry of Idaho, for 1922.

*Pierce district.*—Five placers in the Pierce district produced gold valued at $5,882 and 72 ounces of silver. Most of the gold resulted from the operations of the Bailey dredge on Rhodes Creek, 1½ miles from Pierce.

## CUSTER COUNTY.

The value of the metal output of Custer County increased $131,830 as a result of increases in both the quantity and value of copper and lead.

*Alder Creek district* (*Mackay*).—Six deep mines in the Alder Creek district produced 18,664 tons of ore, containing $42,220 in gold, 57,419 ounces of silver, 1,846,318 pounds of copper, and 623,275 pounds of lead, valued in all at $383,172, or $20.53 a ton. All the output was first-class copper and lead ore, which was shipped to smelters in Utah. A large part of it was copper ore from the Idaho Metals Co., which shipped at the rate of about 1,300 tons a month. This company's property is opened by 100,000 feet of tunnels, drifts, and crosscuts, and the deepest tunnel is 5,500 feet long. In 1922 the company did 3,859 feet of development work. The ore, of which there is a large quantity in reserve, consists of chalcopyrite, bornite, cuprite, and chrysocolla. Considerable oxidized lead ore was shipped from the White Knob, Horse Shoe, and Canady properties.

*Bayhorse district* (*Clayton*).—Four deep mines in the Bayhorse district produced 8,902 tons of ore, containing $471 in gold, 256,093 ounces of silver, 61,178 pounds of copper, and 1,288,746 pounds of lead, valued in all at $335,704, or $37.71 a ton. Nearly all the ore was milling product. The Ramshorn Mining Co. treated by flotation several thousand tons of lead ore and hauled high-grade concentrate to Mackay, Idaho. The ore from the Beardsley mine contains considerable lead as well as silver, and the ore from the Ramshorn mine is exceptionally high in silver, with a small quantity of lead and copper. During the year 2,810 feet of development work was done, and the mill was operated from May 15 to November 7, when it was closed on account of lack of power, which is dependent on the water supply. Lead ore was also concentrated by the Idaho Mine Development Co., which shipped several hundred tons of concentrate to smelters in Utah.

*Stanley Basin district.*—The production of the Stanley Basin district was principally placer gold from the Challis & Sturkey property, 6 miles from Stanley.

*Yankee Fork district.*—Small lots of rich silver ore were shipped from the Why Not and Eustace Mountain properties and placer bullion from the Rough Creek property.

## ELMORE COUNTY.

*Bear Creek district.*—One of the encouraging features of the mining industry of Elmore County was the operation of the large electric dredge at Featherville. The plant, which has a capacity of about 4,000 cubic yards in 24 hours, is equipped with 60 buckets, which have a capacity of 9 cubic feet each. Operations were started in August.

*Middle Boise district.*—Placer gold was shipped from the bench gravel of Middle Boise River near Atlanta, but the deep mines, formerly large producers, were all idle.

### GEM COUNTY.

*West View district.*—Production in the West View district consisted of one lot of silver ore from the Gold Dollar property, a little placer gold, and a test shipment of copper ore from the Liberty mine.

### IDAHO COUNTY.

Idaho County, an important producer of gold in past years, contains several deposits of gold ore which were not worked in 1922 owing to lack of adequate transportation facilities.

*Camp Howard district.*—Four placers in the Camp Howard district produced gold valued at $1,062 and 5 ounces of silver, contributed principally by the Klondyke, Cape Horn, and Wilson claims.

*Clearwater district.*—The Cove placer and other property near Grangeville produced a small quantity of placer gold.

*Dixie district.*—A small lot of ore was treated by amalgamation at the L. & L. property.

*Elk City district.*—One deep mine and five placers in the Elk City district produced 4 tons of ore, $1,259 in gold, and 16 ounces of silver. The output consisted of small lots of placer bullion purchased by storekeepers largely from the Erickson, Red Horse, and Spike Quartz claims. The Homestake Gold Mining Co. did considerable development work in driving a lower tunnel at the American Eagle mine.

*Florence district.*—The Big Three Gold Mining Co. treated a little gold ore in a 1-stamp sampling mill.

*Newsome district.*—Placer gold valued at $405 and 4 ounces of silver was produced from the Beaver Creek and Monitor claims.

*Simpson district.*—A little placer gold was marketed from the Limepoint and various claims on Salmon River, near Lucile.

*Tenmile district.*—Placer bullion was shipped from the Crescent and Tippie claims, on Laurel and Tippie gulches, near Newsome.

*Warren district.*—Four deep mines and five placers in the Warren district produced 437 tons of ore, $16,403 in gold, and 410 ounces of silver, valued together at $16,813. The ore was valued at $29.84 a ton. The increase in the production of gold was due to the operations of the Unity Gold Mines Co., which treated several hundred tons of ore by amalgamation. The mine is opened to a depth of 600 feet by a tunnel 4,000 feet long. Much development work was done in 1922, and a new hydroelectric plant is planned. Most of the placer bullion came from the Golden Rule, Buck Diggings, and Lucky Strike properties.

### KOOTENAI COUNTY.

Though no ore was marketed from Kootenai County, some excitement was caused by the report that platinum and other rare metals had been found in the Homebuilder mine and other property

near Coeur d'Alene. Extensive tests have since proved that the ore contained no platinum.

### LATAH COUNTY.

*Gold Creek district.*—Placer gold was produced from Gold Creek, near Potlatch, by sluicing.

*Hoodoo district.*—The Annie, Liberty, and Hard Work claims, near Harvard, produced $792 in gold and 2 ounces of silver from the banks of the north fork of Palouse River.

### LEMHI COUNTY.

*Mine production of gold, silver, copper, and lead in Lemhi County, Idaho, in 1921 and 1922.*

| Year. | Number of producers. | Ore. | Gold.[a] | Silver.[a] | Copper. | Lead. | Total value. |
|---|---|---|---|---|---|---|---|
| | | *Short tons.* | | *Fine ounces.* | *Pounds.* | *Pounds.* | |
| 1921 | 27 | 13,160 | $28,582 | 56,293 | 18,047 | 2,077,497 | $180,690 |
| 1922 | 33 | 28,435 | 19,582 | 98,927 | 721,180 | 4,434,244 | 459,751 |
| Increase or decrease, 1922. | +6 | +15,275 | −9,000 | +42,634 | +703,133 | +2,356,747 | +279,061 |

[a] Includes placer production.

The value of the metal output of Lemhi County, which increased considerably in 1922, was much below the total of 1920. The unusual feature of the output was the increase in copper from mines in the Eldorado district.

*Eldorado district* (*Salmon*).—The Harmony Mines Co., 8 miles from Baker, operated a 200-ton concentration-flotation plant on copper ore and shipped more than 1,000 tons of copper concentrate. The mine is said to have in reserve about 45,000 tons of ore that contains chalcopyrite, chalcocite, and pyrite. The Pope Shenon mine was operated by lessees, and the volatilization plant was changed to a concentration mill. Several hundred tons of copper concentrate was marketed during the year.

*Eureka district.*—Five deep mines and two placers in the Eureka district produced 66 tons of ore, $452 in gold, 301 ounces of silver, 10,110 pounds of copper, and 3,786 pounds of lead, valued in all at $2,326. The ore had a value of $31.70 a ton. The Mullen dredge was not operated, but a little placer gold was mined from Moose Creek. The Tormey mine produced one lot of copper ore, and the Silverton a lot of silver-lead ore. Gold ore from the Sagamon and Blenwick properties was treated by amalgamation.

*Indian Creek district* (*Ulysses*).—The Buchanan Mining & Leasing Co. operated the Ulysses mine and treated ore by amalgamation. Concentrates on hand from previous operations were treated in an 8-ton cyanide plant.

*Junction district.*—The Leadville and Kimmell properties produced several lots of first-class lead ore.

*Mackinaw district* (*Leesburg*).—One deep mine and four placers in the Mackinaw district produced 65 tons of ore, $3,902 in gold,

and 17 ounces of silver. A small quantity of ore was treated by amalgamation at the Italian mine, and the placer output came from the Hockensmith and Richardson placers, on Arnett and Napias creeks, near Leesburg.

*Mineral Hill district.*—Small lots of ore from the Pine Creek and Speculation claims were treated by amalgamation.

*Spring Mountain district.*—Several lots of oxidized lead ore from the Big Windy mine were shipped to Midvale, Utah.

*Texas district (Gilmore).*—Six deep mines in the Texas district produced 12,022 tons of ore, containing $8,940 in gold, 94,890 ounces of silver, 4,671 pounds of copper, and 4,335,522 pounds of lead, valued in all at $342,915, or $28.52 a ton. Of this output, 7,462 tons was first-class shipping ore and 4,560 tons was concentrated to make 570 tons of lead concentrate. The value of the district output was more than double that of 1921. The Latest Out Mining & Smelting Co. shipped oxidized lead ore at the rate of about 500 tons a month and did 1,000 feet of development work. The Pittsburg-Idaho Co. shipped first-class lead ore and also treated several thousand tons of ore by concentration. In December the property was being operated under the direction of the United States Smelting, Refining & Mining Co., of Salt Lake City. Other shipments were made from the Alex Stevens, Gilmore, Ridgeway Park, and Homestake properties.

*Yellow Jacket district.*—The Black Eagle mine produced one shipment of high-grade gold ore, which was smelted in Utah.

*Reno district (unorganized).*—The Cabin property, near Reno, produced one lot of oxidized lead ore, and 300 feet of development work was done in 1922.

## OWYHEE COUNTY.

The metal output of Owyhee County in 1922 was valued at $28,991, an increase of $5,514. From 1863 to 1922 the county produced gold valued at $21,668,208 and 24,497,028 ounces of silver, or a value for both metals of $40,570,720.

*Carson district (Silver City).*—Ten deep mines in the Carson district produced 1,492 tons of ore, containing $4,915 in gold, 23,452 ounces of silver, 165 pounds of copper, and 293 pounds of lead, valued in all at $28,405, or $19.04 a ton. Small lots of either shipping ore or milling ore were produced by the Pauper, Never Sweat, Homestake, Delamar, Banner, Village Blacksmith, Aberdeen, Ruth, and other claims. The main production of the district came from the Florida Mountain property, where silver ore was concentrated.

*Flint district.*—The Flint mines were operated by the Precious Metal Mines Co. in October, and one small lot of rich silver ore was shipped to a smelter in Utah. The company, which is said to have a large quantity of silver ore in reserve, did 200 feet of drifting and was erecting a 50-ton flotation plant.

*Snake River district.*—A small amount of placer gold was produced from Snake River near Wilson and Melba.

## POWER COUNTY.

About 5 miles from American Falls a small amount of placer gold was produced from Snake River by rockers.

## SHOSHONE COUNTY.

*Mine production of gold, silver, copper, lead, and zinc in Shoshone County, Idaho, in 1921 and 1922.*

| Year. | Deep mines. | Placers. | Ore. | Gold. | Silver. | Copper. | Lead. | Recoverable zinc. | Total value. |
|---|---|---|---|---|---|---|---|---|---|
| | | | *Short tons.* | | *Fine ounces.* | *Pounds.* | *Pounds.* | *Pounds.* | |
| 1921 | 31 | 4 | 1,379,178 | $171,706 | 4,986,263 | 404,615 | 189,086,518 | 33,463 | $13,720,730 |
| 1922 | 36 | 5 | 1,249,536 | [a] 145,865 | [a] 4,690,097 | 341,141 | 182,432,281 | 4,065,810 | 15,147,542 |
| Increase or decrease, 1922. | +5 | +1 | −129,642 | −25,841 | −296,166 | −63,474 | −6,654,237 | +4,032,347 | +1,426,812 |
| Total, 1884–1922. | ..... | ..... | ..... | 6,472,902 | 194,429,204 | 73,552,481 | [b] 3,174,381 | 426,338,583 | 516,168,110 |

[a] Includes placer production of $122,999 in gold and 1,160 ounces of silver.
[b] Short tons.

Shoshone County comprises the Coeur d'Alene region, the most productive mining center in Idaho. It includes several mining districts, the production of which is given separately. The value of the metal output increased more than 10 per cent, though the quantity of gold, silver, copper, and lead was less. The average value of the ore from deep mines in 1922 was $12.02 a ton, and the value in gold and silver was $3.77 a ton. The kinds of ore (nearly all lead ore in 1922) and the contents of each kind have been given in the preceding tables. Most of the ore was milled and yielded 179,692 tons of concentrates, valued at $65.40 a ton. Fourteen milling plants, having a combined daily capacity of approximately 5,700 tons, were active during the year. These mills were concentration plants, and all had flotation equipment. In spite of the fact that the output of all metals but zinc decreased, the mines of Shoshone County were in a better condition than they had been for several years. More prospecting and development work was done, and several new and noteworthy deposits were opened. Accomplishments at the Success, Lookout Mountain, Galena, Big Creek, Western Union, and Cedar Creek properties were said to be especially gratifying. A recent bulletin [6] describes the ore deposits of the region and gives additional views on its geology.

*Beaver district.*—Two deep mines and two placers in the Beaver district produced 20,592 tons of ore, $112 in gold, 35,817 ounces of silver, 1,969,320 pounds of lead, and 2,366,549 pounds of zinc, valued in all at $279,135. The ore had an average value of $13.55 a ton. With the exception of a few lots of lead ore, the entire product of the deep mines was concentrated and separated into zinc and lead concentrates. The Callahan Zinc-Lead Co. operated its mine eight weeks and the mill about six weeks, after being idle nearly two years. The property is said to have about 180,000 tons of lead-zinc sulphide ore in reserve. Extracts from the company's report [7] follow:

> After providing for the cost of maintenance and development of mining properties, buildings, and equipment during the ten months' period while shipments were suspended, in addition to general and administrative expenses for the year, the company was able to close the period with an operating deficit of $150,260.75.

[6] Umpleby, J. B., and Jones, E. L., jr., Geology and ore deposits of Shoshone County, Idaho: U. S. Geol. Survey Bull. 732, 1923.
[7] Callahan Zinc-Lead Co. Tenth Ann. Rept., for year ending Dec. 31, 1922.

For the six weeks' period from November 15, 1922, at which time actual shipments were resumed, 20,516 tons of ore were milled. Shipments during that period were 2,728 tons of zinc concentrates and 1,556 tons of lead-silver concentrates. * * *

Total new development work for the period amounted to 811 feet. An extensive program for the exploration and development of a major part of our holdings, hitherto unexplored, is planned for 1923. * * *

The company, formerly owning 62 per cent of the capitalization of the Galena Mining Co., has now acquired the entire properties of that company. Commercial ore has been developed on five levels. * * *

Prior to the resumption of shipments in November your management closed a new contract with the American Smelting & Refining Co., under the terms of which that company will purchase our entire output of lead-silver concentrates for a period of five years from November 15, 1922. * * * A new contract with the Grasselli Chemical Co. for the purchase of our entire output of zinc concentrates for a two-year period was also consummated during the period.

The zinc concentrates contained 5,794 ounces of silver, 253,193 pounds of lead, and 2,784,176 pounds of zinc (gross). The lead concentrate contained 29,477 ounces of silver and 1,771,238 pounds of lead.

Several lots of lead ore were shipped from the Sunset mine, on Sunset Peak, and placer gold was mined from Potosi Gulch and Placer Gulch, near Murray.

*Coeur d'Alene district.*—The Yukon Gold Co. operated its floating dredge on Prichard Creek the entire year and treated 1,204,611 cubic yards of gravel. The statement to the assessor gave $124,028 as the gross value of the output, and the costs were $103,945, leaving a net profit of $20,083, or less than 2 cents per cubic yard of gravel handled.

*Eagle district.*—Several lots of high-grade sulphide lead ore were shipped from the Jack Waite property, which is opened by two tunnels, 1,400 feet and 2,400 feet long, connected by a raise 425 feet high.

*Evolution district.*—Six deep mines in the Evolution district produced 3,238 tons of ore, containing $279 in gold, 160,455 ounces of silver, 19,634 pounds of copper, and 954,095 pounds of lead, valued in all at $215,860, or $66.66 a ton. Nearly half the ore mined was smelted as first-class lead ore, and the remainder was concentrated. The largest producer was the Western Union mine, opened by 1,000 feet of drifts and crosscuts. About 1,000 tons of rich silver-lead ore was shipped by the company and by lessees from Argentine Spur to East Helena, Mont., and Bradley, Idaho. Since August the mine has been operated by the company, which is doing substantial development work. The Sunshine Mining Co. operated the Yankee Boy mine and shipped both lead ore and concentrate containing considerable silver. The mine is opened by several tunnels, one of which is 2,000 feet long, and development work is progressing under new management. Small lots of silver ore and copper ore were shipped from the Mineral Point, Nellie, Argentine, and Polaris mines.

*Hunter district* (*Mullan*).—Five deep mines in the Hunter district produced 323,847 tons of ore, containing $6,942 in gold, 1,195,144 ounces of silver, 62,141 pounds of copper, 44,325,240 pounds of lead, and 1,699,261 pounds of zinc, valued in all at $3,745,221, or $11.56 a ton. The ore was divided into 278,308 tons concentrated, 33,539 tons shipped as first-class ore, and 12,000 tons of old tailings re-treated

by concentration. The Morning mine of the Federal Mining & Smelting Co. was operated the entire year and shipped crude lead ore and concentrate to various plants of the American Smelting & Refining Co. Zinc concentrate that had been stored was shipped in December, when the price of zinc increased. The mine, which is said to have nearly 700,000 tons of lead-zinc ore in reserve, is opened to a depth of approximately 3,900 feet below the surface. It has an adit 9,500 feet long and is opened 1,650 feet below the adit level. According to the statement to the county assessor, 309,183 tons of ore was mined, which had a gross value of $3,322,820. The cost of extraction was $1,499,041; freight and treatment, $1,301,083; betterment and repairs, $41,239; and net profit, $481,457. Dividends declared by the Federal Mining & Smelting Co. from all properties amounted to $569,345. The printed report[8] of the company says:

> The Morning mine has been worked pretty steadily for about 35 years—since September, 1905, by this company, and prior thereto by several different owners.
>
> The ore shoot is one of the most persistent in the Coeur d'Alene district. It has, within the boundaries of the company's claims, a length of 1,800 feet, and the workings have reached a depth of 3,600 feet below the surface.
>
> How much deeper the ore may go it is impossible to tell, but as there are so far no signs of weakening it is not unreasonable to assume a further depth of at least 600 feet. Assuming like conditions throughout, that should, with present ore reserves, assure us of a further life of about five years. * * *
>
> The Morning ore is a complex mixture of lead and zinc, with siderite and quartzite gangue. Its treatment has always been difficult; and for a number of years the recovery of the metal values was very low. With improved methods, introduced in recent years, the recovery has been greatly increased.

In 1922 the average content of the ore mined was 3.5 ounces of silver, 9.1 per cent of lead, and 4.9 per cent of zinc. The ore reserves were 698,000 tons of fully developed ore, equivalent to about 63,360 tons of lead concentrate, 11,500 tons of zinc concentrate, and 63,360 tons of first-class lead ore.

The Gold Hunter mine was operated most of the year, and the mill was active only 38 days. Milling ore and old tailings were treated in the 500-ton concentration plant, and lead ore and concentrate were shipped to the Bunker Hill smelter. During the year the company did 1,526 feet of development work, and the dump was leased and worked by the Tri-Metals Co.

The 8,124-foot tunnel which is being driven from the Hecla mine to open the Star property had been driven 4,847 feet at the end of the year. When the work is completed it is planned to treat the ore of the Star mine in an electrolytic zinc plant to be built by the Bunker Hill Co. The Independence Lead Mining Co., whose mine is developed by several tunnels, opened considerable ore of milling grade in the You Like vein.

*Lelande district* (*Burke*, *Mace*, *Frisco*).—Five deep mines in the Lelande district produced 341,581 tons of ore, containing $5,833 in gold, 1,543,049 ounces of silver, 126,900 pounds of copper, and 51,951,489 pounds of lead, valued in all at $4,423,345, or $12.95 a ton. Of the total mine output 322,935 tons was reduced to 41,174 tons of concentrates and 18,646 tons was shipped as crude ore. The Lelande district was the second largest producer in the State in 1922, and the production was considerably increased notwithstanding the fact that

[8] Federal Mining & Smelting Co. Ann. Rept. for year ending Dec. 31, 1922.

the Hercules mine was idle the greater part of the year. This mine, one of the largest producers of silver and lead in the State, did not begin operations until July, after which shipments of crude ore and concentrate were sent to East Helena, Mont., as the lead plant at Northport, Wash., controlled by the Day Brothers, was being dismantled. The company operated its 700-ton concentration plant near Wallace and since 1901 has produced about 27,290,000 ounces of silver and nearly 671,000,000 pounds of lead, as well as some zinc, copper, and gold. The statement of the county assessor gave 13,056 tons of crude lead ore and concentrate, which had a gross value of $777,485. The cost of extraction was $682,118; freight and treatment, $185,954; repairs, $7,940; and net loss, $98,527.

The Hecla mine was operated throughout the year and shipped crude ore and concentrate to the Bunker Hill smelter. Most of the ore is treated by concentration and flotation in the 750-ton mill near Mace. According to the statement to the county assessor, 274,581 tons of ore, including 24,293 tons of waste, was mined, which had a gross value of $3,398,544. The cost of extraction was $1,166,984; freight and treatment, $791,371; betterment and repairs, $128,522; and net profit, $1,311,645. Dividends amounted to $950,000 in 1922 and $9,955,000 to date. The following notes are taken from the printed report:[9]

> Development work, including 3,552 feet driven in the Star crosscut, amounted to 8,529 feet. The most important pieces of development work for the year were the continuation of the drift on the 2,000-foot level to the end of and beyond the ore, and the continuation of the Star crosscut, which is being driven from the 2,000-foot level of Hecla works, in conjunction with Bunker Hill & Sullivan Mining & Concentrating Co., for the purpose of exploring the Star property at depth. * * *
>
> The only other piece of development of any note is the crosscut to cut the Wide West vein at depth. This crosscut has advanced 546.8 feet and must be extended 700 feet more to reach the vein under the shallow work described in last year's annual report. * * *
>
> Ore reserves are estimated at 2,057,777 tons, and the surplus January 1, 1923, was $2,048,103.

Of the ore mined, 236,533 tons was milled, making 30,759 tons of concentrate. This, with 14,118 tons of crude ore, was smelted and contained 1,178,124 ounces of silver and 42,490,476 pounds of lead.

The production of the Hecla mine for 19 years was 534,177 tons of crude ore and concentrate, containing 15,172,576 ounces of silver, 529,224,141 pounds of lead, and 941,229 pounds of gross zinc.

The Federal Mining & Smelting Co. also owns property at Mace and Frisco, from which 2,512 tons of lead ore was shipped by lessees. The profit from the Frisco mine was $5,489.

*Placer Center district (Sunset).*—Six deep mines in the Placer Center district produced 35,168 tons of ore, containing $909 in gold, 186,344 ounces of silver, 17,465 pounds of copper, and 6,377,862 pounds of lead, valued in all at $540,393, or $15.37 a ton. The output was divided into 2,268 tons of first-class ore and 32,900 tons of milling ore, which was reduced to 7,407 tons of concentrates. The largest producer was the Tamarack & Custer Consolidated Mining Co. The mine was idle most of the year, but crude ore and concentrate were shipped to East Helena, Mont., during the last quarter.

[9] Hecla Mining Co. Ann. Rept. for year ending Dec. 31, 1922.

The company has acquired the Mammoth tunnel, through which the mine will be developed at depth. According to the statement of the county assessor, the company shipped 8,715 tons of lead concentrate and crude ore, which had a gross value of $537,937. The cost of extraction was $338,434; freight and treatment, $146,077; and betterment and repairs, $119,587. The net loss was $66,161.

The Success Mining Co. opened a large new ore body during the year from the 700-foot level and shipped several hundred tons of lead concentrate as the result of the operation of the 200-ton mill. The company did 1,460 feet of development work in drifts and crosscuts and stored much zinc ore in anticipation of a better market. According to the report of the company,[10] the gross receipts for the last half of 1922 were $104,813, and the net earnings $12,781. The output was 32,053 ounces of silver and 1,024,084 pounds of lead. The new ore opened contains a shoot of clean galena, but most of it is zinc ore.

The Galena property was sold to the Callahan Zinc-Lead Co., and several lots of lead ore were shipped to the Bunker Hill smelter. The property is opened by several tunnels and a vertical shaft 450 feet deep, and much ore was disclosed by persistent development work. Small shipments were made from the Rex, Panhandle, and Sister mines.

*St. Joe district.*—No shipments of copper ore were made from either the Richmond or Montana–Idaho properties, but the vein on the Montana–Idaho was said to have been cut at a depth of 1,800 feet in the 9,000-foot adit. The Richmond mine can also be further developed through this adit.

*Summit district (Murray).*—Though no shipments were made from the mines in the vicinity of Murray, the Cedar Creek Mining Co. is said to have opened considerable silver-lead ore through a 3,000-foot crosscut.

*Yreka district (Kellogg).*—Eleven deep mines in the Yreka district produced 525,043 tons of ore, containing $8,887 in gold, 1,567,742 ounces of silver, 114,818 pounds of copper, and 76,774,077 pounds of lead, valued in all at $5,814,703, or $11.07 a ton. The ore consisted of 6,464 tons of first-class lead ore, 57,836 tons of old tailings, and 460,743 tons of milling ore, which were reduced to 86,634 tons of concentrates. The Yreka district had the most valuable output of the State and was the largest producer of both silver and lead in 1921 and 1922. The Bunker Hill & Sullivan Mining & Concentrating Co. was active the entire year and held its record as the largest producer of silver and lead in the State. Other large producers in the district were the Big Creek, Caledonia, Mullen Milling Co., Sidney, Sierra Nevada, and Hayes Co. The Big Creek mine was operated a short time and shipped a good grade of silver ore as well as silver concentrate. The shipping ore was mined from the upper levels by lessees. In May the Bunker Hill Co. took charge of operations. The Caledonia Mining Co. shipped several thousand tons of stope fillings and did 400 feet of drifting but opened no new ore. The company has no ore in reserve other than an additional quantity of stope fillings. The output [11] was 63,284 ounces of silver

[10] Success Mining Co. Ann. Rept. for year ending Dec. 31, 1922.
[11] Caledonia Mining Co. Ann. Rept. for year ending Dec. 31, 1922.

and 475,912 pounds of lead from 2,993 tons of ore. The gross value was $90,029; net profit, $8,767; and surplus, $315,266.

The Mullan Milling Co. operated a 200-ton flotation plant on old tailings near Kellogg. Several hundred tons of silver-lead concentrate was shipped to Bradley, Idaho, and East Helena, Mont. The Sidney Mining Co., in the Pine Creek region, shipped several hundred tons of silver-lead ore and did 200 feet of development work. The company is said to have 50,000 tons of lead-zinc ore in reserve. Several thousand tons of ore was milled by the Bunker Hill Co. from the Sierra Nevada property. Both the concentrate and crude ore were smelted at Bradley. The company did no new development work in 1922 but has about 25,000 tons of silver-lead ore in reserve. According to the statement made to the county assessor, 8,688 tons of ore was extracted, which had a gross value of $153,658. The net profit was $57,198.

The Hayes Co. treated old tailings in a 100-ton flotation plant and shipped high-grade lead concentrate to Bradley, Idaho. A test shipment of lead ore was made by the Lookout Mountain Mining & Milling Co., which is said to have opened a large body of ore on Pine Creek. The ore is hauled 8 miles by autotruck. In 1922 700 feet of development work was done. One lot of silver-lead concentrate was made by the Thorndson Metal Savings Co., which has a 100-ton concentration-flotation plant and a dump estimated to contain 300,000 tons of silver-lead tailings. Several lots of lead ore were shipped from the Highland Surprise mine, formerly a large producer of both zinc and lead. The company owns a 100-ton concentration plant and is said to have about 20,000 tons of zinc-lead ore in reserve.

According to the statement to the county assessor, the Bunker Hill & Sullivan Mining & Concentrating Co. mined 421,532 tons of ore, which had a gross value of $5,171,228. The cost of extraction was $1,492,414; freight and treatment, $1,838,685; betterment and repairs, $224,759; and net profit, $1,667,523. Dividends aggregated $1,062,750 in 1922 and $27,237,000 to date. Extracts from the printed report[12] follow:

> Production for the year was closely the same as that for 1921, but the better price received for lead resulted in earnings much larger than those made during the preceding year. There has been some decrease in production costs, which still remain comparatively high.
>
> The Bunker Hill smelter and refinery operated continuously and successfully throughout the year and received an increased amount of custom ore. It produced substantially more lead and silver bullion than in any former year of its operation. * * *
>
> Development of the lower levels of the mine has proceeded uninterruptedly throughout the year. Extensions of the No. 16 level have been pushed with very gratifying results, and sinking of the main shaft has been resumed for the opening up of the No. 17 level, which will be 1,600 feet vertically below the Kellogg adit tunnel level. The ore occurrence and structural conditions in the lower levels are found to be entirely normal, and the ore bodies disclosed are equal in size and grade to the bodies found by the upper or older levels of the mine. * * *
>
> We have blocked out ore to date, 13,365 tons in the Stemwinder mine, 123,191 tons in the Sullivan mine, and 3,672,160 tons in the Bunker Hill mine. * * *

[12] Bunker Hill & Sullivan Mining & Concentrating Co. Thirty-fifth Ann. Rept., for year ending Dec. 31, 1922.

The mine was in operation for the full period of 12 months and produced 419,533 tons of concentrating ore and 1,999 tons from exploration at a cost of $1,180,693. * * *

Twenty-eight hundred ninety-five feet of shafts, drifts, and crosscuts were driven at a cost of $35,431. * * *

The West mill concentrators were in operation for the full year, during which 11 days were lost. * * *

During the year 430,219 tons of mine ore were concentrated, making the average work of the concentrators 1,179 tons per day, or say 1,215 tons per 24 hours of actual operation, at a cost of $328,942. * * *

The Sweeny mill was operated solely on lease ore during the year. In cleaning up around the plant 298.39 tons of low-grade ore was picked up and shipped to the smelter.

The ore milled, 430,219 tons, contained 3.62 ounces of silver to the ton and 9.63 per cent of lead. From this ore 76,062 tons of concentrates and middlings was produced, containing 69,327,251 pounds of lead and 1,153,216 ounces of silver. In addition the product from the Sweeny mill, 298 tons, contained 1,626 ounces of silver and 99,471 pounds of lead. The total cost per pound of lead was 4.85 cents. From 1886 to 1922 the company has mined 9,927,659 tons of ore, having a gross value of $108,134,298. Net smelter returns were $64,374,275, and operating profit was $36,174,662.

### TWIN FALLS COUNTY.

*Snake River district.*—Two small placers on the banks of Snake River produced $706 in gold and 2 ounces of silver. Most of the gold was won by sluicing from the Sandy Bar placer.

### VALLEY COUNTY.

*Deadwood Basin district.*—The Merry Blue & Union property, under the management of the H. A. Vernon Co., treated several hundred tons of gold ore and shipped considerable bullion to the Boise assay office. The mine is equipped with a 10-ton amalgamation mill, and 200 feet of development work was done during the year.

*Lake City district.*—Placers near McCall produced a small quantity of gold. The Ruby placer, on Boulder Creek, had the largest production.

### WASHINGTON COUNTY.

*Washington district.*—Three deep mines in the Washington district produced 669 tons of ore, containing $45 in gold, 16,373 ounces of silver, 9,435 pounds of copper, and 1,928 pounds of lead, valued in all at $17,798, or $26.60 a ton. The Enterprise, Egan, and Doris properties produced siliceous silver ore, and part of the output of the Egan mine was milled.

# GOLD, SILVER, COPPER, LEAD, AND ZINC IN WASHINGTON.

(MINES REPORT.)

By C. N. Gerry.[1]

## PRODUCTION.

### SUMMARY.

The value of the mine production of gold, silver, copper, lead, and zinc in Washington in 1922 was nearly 75 per cent more than in 1921. Recovery from conditions that followed the World War, however, has been unusually slow in the mines of Washington, and the output was only about half that of a normal year, or a little more than one-fourth that of 1916, which was more than $2,000,000.

*Mine production of gold, silver, copper, lead, and zinc in Washington in 1921 and 1922.*

| Year. | Number of producers. | Ore. | Gold.[a] | Silver.[a] | Copper. | Lead. | Recoverable zinc. | Total value. |
|---|---|---|---|---|---|---|---|---|
| | | *Short tons.* | | *Fine ounces.* | *Pounds.* | *Pounds.* | *Pounds.* | |
| 1921 | 37 | 22,885 | $128,486 | 142,450 | 251,544 | 143,553 | 449,360 | $332,313 |
| 1922 | 46 | 36,046 | 186,965 | 205,046 | 317,203 | 1,381,199 | 1,228,229 | 580,868 |
| Increase, 1922 | 9 | 13,161 | 58,479 | 62,596 | 65,659 | 1,237,646 | 778,869 | 248,495 |
| Total, 1860–1922 | ..... | ..... | 28,442,523 | 8,170,091 | 17,073,663 | 41,987,075 | 5,297,755 | 41,037,101 |

[a] Includes placer production.

### TREND OF MINING.

Washington has been a fairly large producer of gold since 1860, but the output has been steadily decreasing since 1911. Silver has never been produced in great quantity, but the output has averaged about 200,000 ounces a year since 1891. The value of the silver has never exceeded that of gold, except in 1902, when the Monte Cristo district, in Snohomish County, was a large producer of both gold and silver. The production of copper began in 1899 and reached 1,000,000 pounds in 1912. Since 1920 the output has decreased as a result of curtailed operations at Chewelah. Lead production was first recorded in 1898, and in 1917 Washington produced nearly 10,000,000 pounds of lead, principally from mines near Northport. Since that year the output has fluctuated and dwindled. Most of the zinc was

[1] The figures used in this report were tabulated and the statistical tables compiled by B. N. Patchell, of the United States Geological Survey.

produced in 1916, 1917, and 1922. The output of placers has not been large (2,118.09 ounces of gold and 612 ounces of silver in the last ten years), and most of the metal output of the State has been won from dry and siliceous ores, largely gold ores. Though a general decline is shown in the various kinds of ore in recent years, in all probability an output valued at $2,000,000 could again be made under favorable market conditions.

*Mine production of gold, silver, copper, lead, and zinc in Washington, 1860–1922, by periods.*

| Period. | Gold. | Silver. | Copper. | Lead. | Recoverable zinc. | Total value. |
|---|---|---|---|---|---|---|
| | | *Fine ounces.* | *Pounds.* | *Pounds.* | *Pounds.* | |
| 1860–1870 | $11,400,000 | 150,500 | | | | $11,601,074 |
| 1871–1880 | 1,860,703 | 94,999 | | | | 1,973,444 |
| 1881–1890 | 1,370,884 | 550,037 | | | | 1,913,120 |
| 1891–1900 | 4,498,850 | 1,969,108 | 113,241 | 2,981,569 | | 5,983,080 |
| 1901–1910 | 4,074,768 | 2,162,099 | 1,807,067 | 7,547,394 | | 5,895,147 |
| 1911–1922 | 5,237,318 | 3,243,348 | 15,153,355 | 31,458,112 | 5,297,755 | 13,671,236 |
| | 28,442,523 | 8,170,091 | 17,073,663 | 41,987,075 | 5,297,755 | 41,037,101 |

*Content of ore sold or treated in Washington, 1913–1922.*

**Dry and siliceous ore.**

| Year. | Ore. | Gold. | Silver. | Copper. | Lead. |
|---|---|---|---|---|---|
| | *Short tons.* | *Fine ounces.* | *Fine ounces.* | *Pounds.* | *Pounds.* |
| 1913 | 98,307 | 33,323.21 | 186,696 | 153,633 | 1,144 |
| 1914 | 73,892 | 26,453.86 | 168,499 | 32,431 | 1,816 |
| 1915 | 42,160 | 18,277.72 | 150,633 | 13,451 | 249 |
| 1916 | 70,476 | 26,979.03 | 154,546 | 60,418 | 1,950 |
| 1917 | 65,639 | 23,240.61 | 120,510 | 51,391 | 4,483 |
| 1918 | 47,151 | 14,107.36 | 156,772 | 14,448 | 23,095 |
| 1919 | 29,086 | 12,016.93 | 104,980 | 2,463 | 143 |
| 1920 | 13,096 | 5,549.82 | 45,977 | 2,073 | 1,743 |
| 1921 | 20,199 | 6,015.38 | 68,991 | 3,293 | 3,339 |
| 1922 | 24,782 | 8,830.87 | 106,243 | 2,189 | 17,759 |
| | 484,788 | 174,794.79 | 1,263,847 | 335,790 | 55,721 |

**Copper ore.**

| | | | | | |
|---|---|---|---|---|---|
| 1913 | 16,733 | 158.48 | 140,214 | 800,374 | |
| 1914 | 21,752 | 220.93 | 90,574 | 746,297 | |
| 1915 | 40,417 | 308.59 | 95,766 | 1,007,475 | |
| 1916 | 68,230 | 563.76 | 172,404 | 2,584,230 | 850 |
| 1917 | 75,006 | 281.93 | 154,747 | 2,147,102 | |
| 1918 | 33,583 | 463.82 | 149,858 | 1,907,565 | |
| 1919 | 68,447 | 153.01 | 146,891 | 1,669,060 | |
| 1920 | 62,814 | 223.59 | 146,820 | 1,975,604 | |
| 1921 | 1,332 | 24.91 | 65,716 | 246,017 | |
| 1922 | 6,086 | 38.40 | 68,239 | 312,912 | 239 |
| | 444,400 | 2,437.42 | 1,231,229 | 13,396,636 | 1,089 |

**Lead ore.**

| | | | | | |
|---|---|---|---|---|---|
| 1913 | 645 | 0.14 | 4,260 | 74 | 201,343 |
| 1914 | 303 | | 5,705 | | 63,691 |
| 1915 | 989 | 2.23 | 9,344 | | 294,966 |
| 1916 | 9,099 | .87 | 8,002 | 374 | 5,019,170 |
| 1917 | 16,407 | 1.55 | 5,630 | 535 | 9,739,302 |
| 1918 | 8,125 | .72 | 3,418 | 393 | 5,248,720 |
| 1919 | 3,281 | 1.60 | 5,251 | 1,028 | 2,118,886 |
| 1920 | 8,660 | 1.99 | 4,123 | | 5,753,976 |
| 1921 | 354 | 26.56 | 7,695 | 2,234 | 136,974 |
| 1922 | 3,624 | 12.72 | 30,463 | 2,102 | 1,363,201 |
| | 51,487 | 48.38 | 83,891 | 6,740 | 29,940,229 |

*Content of ore sold or treated in Washington, 1913–1922*—Continued.

**Zinc and lead-zinc ore.**

| Year. | Ore. | Gold. | Silver. | Copper. | Lead. | Recoverable zinc. |
|---|---|---|---|---|---|---|
| | *Short tons.* | *Fine ounces.* | *Fine ounces.* | *Pounds.* | *Pounds.* | *Pounds.* |
| 1915 | 3,111 | | | | | 244,906 |
| 1916 | 17,193 | | 65 | | 377,304 | 1,693,734 |
| 1917 | 15,067 | 8.22 | 1,347 | 490 | 45,902 | 1,195,567 |
| 1918 | 52 | | | | | 38,873 |
| 1919 | | | | | | |
| 1920 | 658 | | | | 5,820 | 426,496 |
| 1921 | 1,000 | | | | 3,240 | 449,360 |
| 1922 | 1,554 | | 52 | | | 1,228,229 |
| | 38,635 | 8.22 | 1,464 | 490 | 432,266 | 5,277,165 |

## ORE.

The quantity of ore sold or treated in Washington increased nearly 58 per cent in 1922 as a result of activity in Stevens, Whatcom, and Okanogan counties. The average value of the ore increased from $14.38 a ton in 1921 to $16.02 in 1922, but the value in gold and silver decreased from $11.70 a ton to $10.78. Of the total output of ore in 1922 only 50 per cent was gold ore, the decrease being due to the idleness of several mines at Republic.

The total and average content of both crude ore and concentrates shipped are given on pages 250–251.

*Ore and metals produced in Washington in 1922.*

| Source of production. | Ore. | | Gold. | | Silver. | |
|---|---|---|---|---|---|---|
| | Short tons. | Per cent. | Fine ounces. | Per cent. | Fine ounces. | Per cent. |
| Dry gold ore | 17,944 | 49.78 | 8,764.15 | 96.90 | 29,572 | 14.43 |
| Dry silver ore | 6,838 | 18.97 | 66.72 | .75 | 76,671 | 37.39 |
| Copper ore | 6,086 | 16.89 | 38.40 | .42 | 68,239 | 33.28 |
| Lead ore | 3,624 | 10.05 | 12.72 | .13 | 30,463 | 14.86 |
| Zinc ore | 1,554 | 4.31 | | | 52 | .02 |
| Total deep mines | 36,046 | 100.00 | 8,881.99 | 98.20 | 204,997 | 99.98 |
| Total placers | | | 162.44 | 1.80 | 49 | .02 |
| Total deep mines and placers, 1922 | 36,046 | 100.00 | 9,044.43 | 100.00 | 205,046 | 100.00 |
| Total deep mines and placers, 1921 | 22,885 | | 6,215.51 | | 142,450 | |
| Increase, 1922 | 13,161 | | 2,828.92 | | 62,596 | |

| Source of production. | Copper. | | Lead. | | Zinc. | |
|---|---|---|---|---|---|---|
| | Pounds. | Per cent. | Pounds. | Per cent. | Pounds. | Per cent. |
| Dry gold ore | | | | | | |
| Dry silver ore | 2,189 | 0.69 | 17,759 | 1.28 | | |
| Copper ore | 312,912 | 98.65 | 239 | .02 | | |
| Lead ore | 2,102 | .66 | 1,363,201 | 98.70 | | |
| Zinc ore | | | | | 1,228,229 | 100.00 |
| Total deep mines | 317,203 | 100.00 | 1,381,199 | 100.00 | 1,228,229 | 100.00 |
| Total deep mines, 1921 | 251,544 | | 143,553 | | 449,360 | |
| Increase, 1922 | 65,659 | | 1,237,646 | | 778,869 | |

The gold ore was about evenly divided into shipping ore from Republic and ore from Whatcom County, which was amalgamated. These ores averaged $10.10 in gold and 1.65 ounces of silver to the ton.

*Content of dry gold ore sold or treated in Washington in 1922.*

| County. | Ore. | Gold. | Silver. |
|---|---|---|---|
| | *Short tons.* | *Fine ounces.* | *Fine ounces.* |
| Chelan | 10 | 8.17 | 4 |
| Ferry | 9,058 | 4,127.51 | 29,321 |
| Whatcom | 8,876 | 4,628.47 | 247 |
| | 17,944 | 8,764.15 | 29,572 |

The Ruby mine was the largest producer of silver ore, most of which was of milling grade. The silver ores averaged $0.20 in gold and 11.21 ounces of silver to the ton and a little copper and lead.

*Content of dry silver ore sold or treated in Washington in 1922.*

| County. | Ore. | Gold. | Silver. | Copper. | Lead. |
|---|---|---|---|---|---|
| | *Short tons.* | *Fine ounces.* | *Fine ounces.* | *Pounds.* | *Pounds.* |
| Ferry | 240 | 3.77 | 3,302 | 27 | 5,131 |
| King | 25 | .34 | 360 | ..... | ..... |
| Okanogan | 6,441 | 61.90 | 67,125 | 1,679 | 6,338 |
| Stevens | 132 | .71 | 5,884 | 483 | 6,290 |
| | 6,838 | 66.72 | 76,671 | 2,189 | 17,759 |

The copper ore, principally from Stevens County and largely milling ore, averaged $0.13 in gold and 11.21 ounces of silver to the ton and 2.57 per cent of copper.

*Content of copper ore sold or treated in Washington in 1922.*

| County. | Ore. | Gold. | Silver. | Copper. | Lead. |
|---|---|---|---|---|---|
| | *Short tons.* | *Fine ounces.* | *Fine ounces.* | *Pounds.* | *Pounds.* |
| Kittitas | 125 | 0.30 | 25 | 3,582 | ..... |
| Okanogan | 4 | 2.00 | 40 | 2,001 | 239 |
| Stevens | 5,957 | 36.10 | 68,174 | 307,329 | ..... |
| | 6,086 | 38.40 | 68,239 | 312,912 | 239 |

The lead ore, part of which was milled, averaged $0.07 in gold and 8.41 ounces of silver to the ton and 18.81 per cent of lead.

*Content of lead ore sold or treated in Washington in 1922.*

| County. | Ore. | Gold. | Silver. | Copper. | Lead. |
|---|---|---|---|---|---|
| | *Short tons.* | *Fine ounces.* | *Fine ounces.* | *Pounds.* | *Pounds.* |
| Ferry | 6 | ..... | 100 | ..... | 1,227 |
| Okanogan | 151 | 0.02 | 1,145 | 856 | 13,564 |
| Pend Oreille | 13 | .24 | 220 | 62 | 7,372 |
| Stevens | 3,454 | 12.46 | 28,998 | 1,184 | 1,341,038 |
| | 3,624 | 12.72 | 30,463 | 2,102 | 1,363,201 |

### GOLD.

The mine production of gold in Washington increased nearly 46 per cent as a result of the resumption of mining in Whatcom County. More than 51 per cent of the gold was obtained from ore treated in gold and silver mills, 46 per cent from ores shipped directly to smelters, 2 per cent from placers, and nearly 1 per cent from concentrates. Most of the gold, or 97 per cent, had its source in gold ore, largely from Whatcom and Ferry counties. The largest producers of gold in 1922 were the Boundary Red Mountain mine, in Whatcom County, and the Knob Hill, Quilp, and Surprise mines, at Republic, in Ferry County.

### SILVER.

The mine production of silver in Washington increased 44 per cent. Stevens County made the largest production, and Okanogan and Ferry counties followed. Crude ore shipped to smelters supplied 59 per cent of the silver, and concentrates nearly all the remainder. Silver ore contained 37 per cent of the silver, copper ore 33 per cent, and gold ore and lead ore nearly 15 per cent each. The United Silver-Copper mine was the largest producer of silver in 1922, though the output was comparatively small. The next three silver producers were the Pyrargyrite, Old Dominion, and Quilp mines.

### COPPER.

The mine production of copper in Washington increased 26 per cent in quantity owing to better market conditions. Production, however, was unusually small, and the Sunset mine, in Snohomish County, was still idle. Practically all the copper came from first-class ore smelted at Tacoma. The United Silver-Copper mine, northeast of Chewelah, was the only large producer of copper.

### LEAD.

The mine production of lead in Washington was nearly ten times that of 1921, but the output was far below that of a normal year. Shipments from the Electric Point mine, the largest producer of lead in the last decade, were small, but an increase was made from other property in Stevens County. The Gladstone mine, near Northport, became a regular producer of high-grade lead ore, and the Santa Rita mine, west of Springdale, produced much ore of milling grade.

### ZINC.

The output of recoverable zinc in Washington in 1922 was 1,228,229 pounds, or nearly three times the output of 1921. Carbonate ore from the Black Rock mine, near Northport, was shipped to the electrolytic zinc plant at Trail, British Columbia.

### MINING INDUSTRY.

The mining companies of Washington have been slow to respond to the general improvement in mining conditions. As a result the output of the mines compares unfavorably with that of recent years, notwithstanding the high prices of metal and reduced freight rates. Labor conditions improved, but men were still scarce at many camps, and in general the cost of mining was high. The lead plant

at Northport was idle and in September was being dismantled. Custom lead ore formerly sent to this plant is now being shipped to the Bunker Hill smelter at Bradley, Idaho, and siliceous ore from Republic is smelted at Trail, British Columbia. After a long period of quiescence several mines at Republic were beginning to show some activity in December.

## METALLURGIC INDUSTRY.

Eight milling plants in Washington were active in 1922. Six of these were concentration mills, three of which had flotation plants; one used amalgamation; and one concentration and cyanidation.

Ore and concentrate from mines in Washington were smelted at Tacoma, Wash.; Trail, British Columbia; Bradley, Idaho; and Midvale, Utah. The lead plant at Northport was being dismantled after having been sold to the American Smelting & Refining Co. The only smelting operations within the State were carried on at the plant at Tacoma, Wash., which treats comparatively little ore from Washington.

Twenty-five per cent of the ore—9,127 tons—was treated by amalgamation or cyanidation, principally the former. The bullion contained gold valued at $95,960 and 3,157 ounces of silver, or an average in both metals of $10.86 a ton. For these mills 75 pounds of mercury was purchased and 1,000 pounds of potassium cyanide consumed. The mercury purchased represented 0.0084 pound per ton of ore treated and 0.015 pound per ounce of bullion recovered. The consumption of cyanide was 4.15 pounds per ton of ore treated and 0.34 pound per ounce of bullion recovered.

More than 37 per cent of the output of ore was concentrated and produced 928 tons of concentrates, which were divided almost evenly into siliceous, copper, and lead concentrates. The increase of 377 tons was principally in copper and lead concentrates.

*Metals produced from Washington concentrates in 1922.*

**By counties.**

| County. | Ore to concentrating mills. | Concentrates. | Gold. | Silver. | Copper. | Lead. | Total value of concentrates. |
|---|---|---|---|---|---|---|---|
| | *Short tons.* | *Short tons.* | *Fine ounces.* | *Fine ounces.* | *Pounds.* | *Pounds.* | |
| Ferry | ..... | 10 | 0.48 | 404 | 27 | 5,131 | $700 |
| King | 25 | 1 | .34 | 360 | ..... | ..... | 367 |
| Kittitas | 125 | 13 | .30 | 25 | 3,582 | ..... | 515 |
| Okanogan | 6,485 | 315 | 60.04 | 59,889 | 2,078 | 14,774 | 62,223 |
| Stevens | 6,860 | 589 | 13.13 | 19,297 | 74,828 | 236,948 | 42,702 |
| | 13,495 | 928 | 74.29 | 79,975 | 80,515 | 256,853 | 106,507 |

**By kinds of concentrates.**

| Kind. | Concentrates. | Gold. | Silver. | Copper. | Lead. | Total value of concentrates. |
|---|---|---|---|---|---|---|
| | *Short tons.* | *Fine ounces.* | *Fine ounces.* | *Pounds.* | *Pounds.* | |
| Dry and siliceous | 291 | 60.38 | 59,204 | 1,243 | 1,350 | $60,694 |
| Copper | 328 | 6.80 | 12,583 | 78,284 | ..... | 23,291 |
| Lead | 309 | 7.11 | 8,188 | 988 | 255,503 | 22,522 |

*Metals produced from Washington concentrates in 1922*—Continued.

**Average content.**

| Kind of concentrates. | Concentrates. | Gold. | Silver. | Copper. | Lead. | Total value. |
|---|---|---|---|---|---|---|
| | *Short tons.* | *Fine ounces per ton.* | *Fine ounces per ton.* | *Per cent.* | *Per cent.* | |
| Dry and siliceous | 291 | 0.21 | 203.45 | 0.21 | 0.23 | $208.57 |
| Copper | 328 | .02 | 38.36 | 11.93 | ..... | 71.01 |
| Lead | 309 | .02 | 26.50 | .16 | 41.34 | 72.89 |
| | 928 | .08 | 86.18 | 4.34 | 13.84 | 114.77 |

More than 37 per cent of the ore was mined and shipped directly to smelters, and most of it came from Ferry and Stevens counties. Of the shipping ore, 69 per cent was dry and siliceous ore. All the copper ore and most of the lead ore shipped was sulphide, and all the zinc ore was oxidized.

*Mine production of metals from Washington crude ore shipped to smelters in 1922.*

**By counties.**

| County. | Ore. | Gold. | Silver. | Copper. | Lead. | Recoverable zinc. | Total value. |
|---|---|---|---|---|---|---|---|
| | *Short tons.* | *Fine ounces.* | *Fine ounces.* | *Pounds.* | *Pounds.* | *Pounds.* | |
| Ferry | 9,063 | 4,125.42 | 29,413 | ..... | 1,227 | ..... | $114,761 |
| Okanogan | 111 | 3.88 | 8,421 | 2,458 | 5,367 | ..... | 9,128 |
| Pend Oreille | 13 | .24 | 220 | 62 | 7,372 | ..... | 638 |
| Stevens | 4,237 | 36.14 | 83,811 | 234,168 | 1,110,380 | 1,228,229 | 247,251 |
| | 13,424 | 4,165.68 | 121,865 | 236,688 | 1,124,346 | 1,228,229 | 371,778 |

**By kinds of ore.**

| | | | | | | | |
|---|---|---|---|---|---|---|---|
| Dry and siliceous | 9,295 | 4,127.98 | 43,478 | 919 | 11,278 | ..... | $129,555 |
| Copper | 1,561 | 31.60 | 55,656 | 234,628 | 239 | ..... | 87,997 |
| Lead ore | 1,014 | 6.10 | 22,679 | 1,141 | 1,112,829 | ..... | 84,165 |
| Zinc ore | 1,554 | ..... | 52 | ..... | ..... | 1,228,229 | 70,061 |

**Average content.**

| | *Short tons.* | *Fine ounces per ton.* | *Fine ounces per ton.* | *Per cent.* | *Per cent.* | *Per cent.* | |
|---|---|---|---|---|---|---|---|
| Dry and siliceous | 9,295 | 0.44 | 4.68 | ..... | 0.06 | ..... | $13.94 |
| Copper: | | | | | | | |
| Sulphide | 1,561 | .02 | 35.65 | 7.52 | .01 | ..... | 56.37 |
| Lead: | | | | | | | |
| Oxidized | 115 | ..... | 4.41 | .02 | 65.74 | ..... | 76.77 |
| Sulphide | 899 | .01 | 24.66 | .06 | 53.48 | ..... | 83.80 |
| Zinc: | | | | | | | |
| Oxidized | 1,554 | ..... | .03 | ..... | ..... | 39.52 | 45.08 |
| | 13,424 | .31 | 9.08 | .88 | 4.19 | 4.57 | 27.70 |

## REVIEW BY COUNTIES.

*Mine production of gold, silver, copper, lead, and zinc in Washington in 1922, by counties.*

| County. | Ore (short tons). | Gold. | | Silver. | |
|---|---|---|---|---|---|
| | | Fine ounces. | Value. | Fine ounces. | Value. |
| Asotin | ..... | 2.76 | $57 | ..... | ..... |
| Chelan | 10 | 8.17 | 169 | 4 | $4 |
| Clallam | ..... | 8.71 | 180 | 1 | 1 |
| Ferry | 9,304 | 4,145.06 | 85,686 | 32,725 | 32,725 |
| King | 25 | .34 | 7 | 360 | 360 |
| Kittitas | 125 | 127.13 | 2,628 | 68 | 68 |
| Okanogan | 6,596 | 69.08 | 1,428 | 68,312 | 68,312 |
| Pend Oreille | 13 | .24 | 5 | 220 | 220 |
| Snohomish | ..... | 5.18 | 107 | 1 | 1 |
| Stevens | 11,097 | 49.29 | 1,019 | 103,108 | 103,108 |
| Whatcom | 8,876 | 4,628.47 | 95,679 | 247 | 247 |
| | 36,046 | 9,044.43 | 186,965 | 205,046 | 205,046 |

| County. | Copper. | | Lead. | | Recoverable zinc. | | Total value. |
|---|---|---|---|---|---|---|---|
| | Pounds. | Value. | Pounds. | Value. | Pounds. | Value. | |
| Asotin | ..... | ..... | ..... | ..... | ..... | ..... | $57 |
| Chelan | ..... | ..... | ..... | ..... | ..... | ..... | 173 |
| Clallam | ..... | ..... | ..... | ..... | ..... | ..... | 181 |
| Ferry | 27 | $4 | 6,358 | $350 | ..... | ..... | 118,765 |
| King | ..... | ..... | ..... | ..... | ..... | ..... | 367 |
| Kittitas | 3,582 | 484 | ..... | ..... | ..... | ..... | 3,180 |
| Okanogan | 4,536 | 612 | 20,141 | 1,108 | ..... | ..... | 71,460 |
| Pend Oreille | 62 | 8 | 7,372 | 405 | ..... | ..... | 638 |
| Snohomish | ..... | ..... | ..... | ..... | ..... | ..... | 108 |
| Stevens | 308,996 | 41,714 | 1,347,328 | 74,103 | 1,228,229 | $70,009 | 289,953 |
| Whatcom | ..... | ..... | ..... | ..... | ..... | ..... | 95,926 |
| | 317,203 | 42,822 | 1,381,199 | 75,966 | 1,228,229 | 70,009 | 580,808 |

*Ore sold or treated, deep mines producing, and average value of ores in Washington in 1921 and 1922, by counties.*

| County. | Ore sold or treated, 1922 (short tons). | | Number of deep mines producing. | | Average total value per ton.[a] | | Average value per ton in gold and silver.[a] | |
|---|---|---|---|---|---|---|---|---|
| | Total. | Increase or decrease. | 1921 | 1922 | 1921 | 1922 | 1921 | 1922 |
| Chelan | 10 | −10 | 1 | 1 | $10.65 | $17.30 | $10.65 | $17.30 |
| Ferry | 9,304 | −3,781 | 7 | 9 | 8.98 | 12.73 | 8.97 | 12.70 |
| King | 25 | +25 | ..... | 1 | ..... | 14.68 | ..... | 14.68 |
| Kittitas | 125 | +125 | ..... | 1 | ..... | 4.12 | ..... | .25 |
| Okanogan | 6,596 | +2,243 | 11 | 5 | 9.56 | 10.82 | 9.17 | 10.56 |
| Pend Oreille | 13 | +13 | ..... | 2 | ..... | 49.08 | ..... | 17.31 |
| Stevens | 11,097 | +8,545 | 6 | 13 | 53.01 | 26.13 | 29.68 | 9.38 |
| Whatcom | 8,876 | +6,001 | 1 | 1 | 12.01 | 10.81 | 12.01 | 10.81 |
| | 36,046 | +13,161 | 26 | 33 | 14.38 | 16.02 | 11.70 | 10.78 |

[a] Placer product excluded.

### ASOTIN COUNTY.

A small quantity of placer gold was mined from the banks of Snake River near Asotin.

## CHELAN COUNTY.

*Blewett district.*—The mines of the Blewett district were idle in 1922, but several small lots of ore were tested by amalgamation.

## CLALLAM COUNTY.

*Ozette district.*—Placer gold was mined from the beach sands near Royal.

## FERRY COUNTY.

*Mine production of gold, silver, copper, and lead in Ferry County, Wash., in 1921 and 1922.*

| Year. | Number of producers. | Ore. | Gold. | Silver. | Copper. | Lead. | Total value. |
|---|---|---|---|---|---|---|---|
| | | *Short tons.* | | *Fine ounces.* | *Pounds.* | *Pounds.* | |
| 1921 | 7 | 13,085 | $88,290 | 29,099 | 1,213 | ..... | $117,545 |
| 1922 | 10 | 9,304 | [a] 85,686 | [a] 32,725 | 27 | 6,358 | 118,765 |
| Increase or decrease, 1922. | +3 | −3,781 | −2,604 | +3,626 | −1,186 | +6,358 | +1,220 |

[a] Includes placer production.

*Columbia River district.*—Placer gold was mined from the banks of Columbia River 10 miles south of Kettle Falls.

*Keller district.*—The Iron Creek Mining & Milling Co. treated several hundred tons of ore by cyanidation and concentration. Silver bullion was shipped to the mint, and lead ore and concentrate were smelted at Bradley, Idaho. A vein of silver-lead ore was said to have been opened in March, and it was planned to sink the shaft an additional 200 feet. Development work was continued at the Addison mine, which has copper ore of milling grade.

*Republic district.*—Eight deep mines in the Republic district produced 9,058 tons of ore, containing $85,323 in gold and 29,321 ounces of silver, valued together at $114,644, or $12.66 a ton. Practically all the ore was shipped to smelters, no milling plants being operated in the district. From 1896 to the end of 1922 the district produced 571,258 tons of ore, containing $7,218,093 in gold and 2,127,273 ounces of silver, valued together at $8,541,888. The largest producers in the district were the Quilp, Knob Hill, and Surprise mines. Other producers were the Old Republic and Last Chance properties. The production of the Republic district has been unusually small in the last three years on account of litigation and the excessive cost of mining, but several properties started substantial operations in December. The Last Chance mine, a large producer in the past, resumed operations and made several shipments at the end of the year. Litigation with adjoining property was settled early in the year in favor of the Last Chance mine. In June the Knob Hill property was reopened by the Balaklala Consolidated Copper Co. A new hoist was installed, and development work consisted of 200 feet of inclined double-compartment shaft and 275 feet of drifts. The work has opened several thousand tons of siliceous gold ore of good grade. The Quilp Mining Co., the largest and most regular shipper of the district, planned to sink its shaft to the 900-foot level. When completed it will be the deepest shaft in the district.

The Surprise-Lone Pine-Pearl group produced about 300 tons of ore a month, which was shipped to Trail, British Columbia. An occasional shipment was made from the Old Republic mine, but the San Poil property was idle. Nearly all the ore from the Republic district was shipped to Trail, British Columbia, in 1922, and the operators were therefore paid the foreign price of silver.

### KING COUNTY.

*Miller River district.*—The Snoqualmie Mining Co. operated a concentration mill for a few days on silver ore.

### KITTITAS COUNTY.

*Cle Elum district.*—The Mineral Creek Mining Co. made a test mill run on copper ore and shipped one lot of concentrates to Tacoma.

*Swauk district.*—Seven placers in the Swauk district produced gold valued at $2,622 and 43 ounces of silver. The largest producers were the Golden Rule, Black Jack, and Weninger properties. The dredge of the Swauk Mining & Dredging Co. was idle, and reports regarding the installation of a new dredge were not fulfilled.

### OKANOGAN COUNTY.

Five deep mines and one placer in Okanogan County produced ore and bullion valued at $71,460, an increase of $29,824.

*Nespelem district (Moses).*—The Apache Mining Co. made one test shipment of silver ore.

*Palmer Mountain district.*—Three mines in the Palmer Mountain district produced 6,594 tons of ore, containing $1,318 in gold, 67,865 ounces of silver, 4,515 pounds of copper, and 20,001 pounds of lead, valued in all at $70,892, or $10.75 a ton. Practically all this ore was concentrated, and most of it came from the Ruby mine, operated by the Pyrargyrite Mining Co. Other than the United Silver-Copper mine at Chewelah, the Ruby mine was the most important silver producer in the State. The ore is treated in a concentration plant which has flotation equipment. Lead ore was milled by the Four Metals Mining Co. and one lot of concentrate shipped to East Helena, Mont.

### PEND OREILLE COUNTY.

*Metaline district.*—No ore was shipped from the Metaline district in 1922, but a new milling plant was purchased for the Oriole mine.

*Newport district.*—Development was continued at the Bead Lake property, and the erection of a new 100-ton milling plant and aerial tramway was completed. The ore contains galena and chalcopyrite. Small test shipments of lead ore were made from the Eagle and Gray Goose mines.

### PIERCE COUNTY.

The Tacoma Smelting Co. operated its copper smelter and refinery in 1922, but not at full capacity. Much ore was received from Alaska and British Columbia, but little from Washington.

## SNOHOMISH COUNTY.

*Index district.*—The mine and mill of the Sunset Copper Co. were idle during 1921 and 1922, and this accounts in part for the decrease in the production of copper in the State since 1920. The company has a new concentration-flotation plant, which was completed in 1918 and was a large producer of copper from 1918 to 1920.

*Sultan district.*—Small lots of placer bullion were produced in the vicinity of Sultan.

## STEVENS COUNTY.

*Mine production of gold, silver, copper, lead, and zinc in Stevens County, Wash., in 1921 and 1922.*

| Year. | Number of producers. | Ore. | Gold. | Silver. | Copper. | Lead. | Recoverable zinc. | Total value. |
|---|---|---|---|---|---|---|---|---|
| | | *Short tons.* | | *Fine ounces.* | *Pounds.* | *Pounds.* | *Pounds.* | |
| 1921 | 7 | 2,552 | $580 | 75,189 | 246,017 | 118,251 | 449,360 | $135,294 |
| 1922 | 13 | 11,097 | 1,019 | 103,108 | 308,996 | 1,347,328 | 1,228,229 | 289,953 |
| Increase, 1922 | 6 | 8,545 | 439 | 27,919 | 62,979 | 1,229,077 | 778,869 | 154,659 |

In Stevens County, which is the most important mining area in the State, a general increase was recorded in the five metals. The value of the output, however, was only about one-third of that of 1920.

*Bossburg district.*—The Young America mine was operated by lessees, and one lot of lead ore was shipped to the Bunker Hill smelter.

*Chewelah district.*—From 1901 to the end of 1922 the Chewelah district has produced 362,668 tons of ore, yielding $73,364 in gold, 1,499,282 ounces of silver, 9,133,380 pounds of copper, and 265,139 pounds of lead, having a total value of $3,066,552. The United Silver-Copper Mining Co. operated its concentration-flotation mill a short time late in 1922 and shipped crude copper ore and concentrate to Tacoma, Wash. The mine, which was not vigorously operated in 1922, is developed by a vertical shaft 1,400 feet deep, 6,000 feet of drifts, and a tunnel 5,000 feet long. No report of operations was issued, but the company is said to have 10,000 tons of low-grade copper-silver ore in reserve.

*Colville district.*—About 1,000 feet of development work was done in the Old Dominion mine, operated by the Dominion Silver-Lead Mining Co. The ore body is a replacement deposit in limestone, and one lot of sulphide lead ore containing considerable silver was shipped to the Bunker Hill smelter. At the Chloride Queen mine silver-lead ore was opened in a 1,200-foot tunnel at a depth of 750 feet.

*Northport district.*—Six deep mines in the Northport district produced 2,489 tons of ore, containing $5 in gold, 2,418 ounces of silver, 81 pounds of copper, 1,067,668 pounds of lead, and 1,228,229 pounds of recoverable zinc, valued in all at $131,165, or $52.70 a ton. All the output was first-class shipping ore, and a decided increase was made in the shipments of both lead ore and zinc ore. The Elec-

tric Point mine was idle in 1922, but several hundred tons of lead ore in stock was shipped for smelting. The mine is said to have a large quantity of lead ore of good grade, but as the costs of mining, hauling, and freight are high and the ore contains no silver, the margin of profit is small when the price of lead is low. The Northport lead plant was idle the first half of 1922 and in July was sold to the American Smelting & Refining Co. The roasting machinery and blast furnaces were dismantled and shipped to East Helena, Mont., and the Cottrell plant was moved to Chewelah, Wash., to be used in the plant of the Northwest Magnesite Co. Since the closing of the Northport smelter much of the ore from Stevens County is shipped to the Bunker Hill smelter at Bradley, Idaho.

Lead ore of good grade and in considerable quantity was shipped from the Gladstone mine, near Leadpoint, which has become a regular producer. Development work consisted of 300 feet of drifting, during which several additional "chimneys" of ore were opened. One lot of silver ore was shipped from the Hazel mine, at Red Top Mountain, 8 miles southeast of Northport. The Black Rock mine, 6 miles northeast of Northport, produced a large quantity of zinc carbonate ore, most of which was shipped to the electrolytic zinc plant at Trail, British Columbia. One lot was shipped to Blende, Colo., and some lead ore went to Bradley, Idaho. The mine is opened by a vertical shaft 370 feet deep and a tunnel 325 feet long. High-grade sulphide zinc ore has also been opened.

*Orient district.*—The First Thought mine, which was unwatered and retimbered to the 600-foot level, is said to have a large quantity of low-grade gold ore, for which a mill is planned.

*Springdale district.*—Four deep mines in the Springdale district produced 2,587 tons of ore, containing $152 in gold, 12,284 ounces of silver, 616 pounds of copper, and 257,966 pounds of lead, valued in all at $26,707, or $10.32 a ton. Nearly all the output was lead ore of milling grade. The largest producer in the district was the Cleveland mine, operated by the Santa Rita Mining & Milling Co. In the course of development ore was treated by concentration and flotation, and several hundred tons of lead concentrate were shipped to Bradley, Idaho. The ore also contains zinc, but no separate product was made. Several lots of rich silver ore were shipped from the Silver Queen, Silver Seal, and Providence properties. Development on the 400-foot level of the Silver Mountain property was said to have opened several feet of silver-lead ore.

## WHATCOM COUNTY.

*Mount Baker district.*—The largest gold production of the State was that of the Boundary Red Mountain mine, south of Sardis, British Columbia. Ore was treated by amalgamation in a 10-stamp mill, but on account of difficulty in employing sufficient help the property was operated somewhat intermittently during the first half of the year. The mine, which is opened to a depth of 500 feet by tunnels and drifts on the vein, has much gold ore in reserve and good prospects of considerable ore by further development.

# COPPER.

By H. A. C. Jenison.[1]

## INTRODUCTION.

The production of metallic copper from the ore for general consumption requires at least three distinct operations—mining, smelting, and refining. Each of these operations embraces several processes, of which the preparation of the ore for smelting is ordinarily the most varied and complicated. The Lake Superior native-copper ores are the only important American source of copper in which the three operations are not necessary for the production of commercial copper. On account of these three operations it is possible to determine approximately the production of copper in the United States by the collection of mine statistics, smelter statistics, or refinery statistics. These three sets of statistics can never agree exactly, but each set has a peculiar advantage, and the coordination of all three accurately determines the essential features of the copper industry for the year.

The principal value of the mine statistics is that they determine most accurately the geographic distribution of production. They are also the only source of accurate data on the character of the ore, the copper and precious-metal contents of the ore, and the degree to which the ore is concentrated before smelting. They show the quantity of ore shipped from the mines but are less accurate than the smelter figures in that they represent the estimated recoverable copper content and not the actual recovery. The smelter statistics show with fair accuracy the geographic distribution of the production and give accurately the quantity of crude copper actually recovered from the ores, including considerable copper from sulphur, lead, zinc, and siliceous ores that carry so little copper that the mines are not paid for it and frequently do not report it. The smelter figures also differ from the mine figures by the quantity of ore, matte, and other materials in stock at the beginning and at the end of the year. The refinery statistics indicate the quantity of copper made available for consumption and the quantity of precious metals recovered from copper ore but do not permit accurate distribution of production according to source, even the separation of production according to foreign and domestic sources being uncertain. The refinery figures differ from the smelter figures by the quantity of stocks of unrefined copper at the beginning and the end of each year.

The principal cause of the differences in the figures from the three different sources is the time factor involved in the successive stages of the production of refined copper. The interval from the time the

[1] The statistics in this report were prepared by Miss Helena M. Meyer, and the data on imports and exports were compiled from records of the Bureau of Foreign and Domestic Commerce by J. A. Dorsey, both of the United States Geological Survey.

ore is mined until the refined copper is available for commercial use is about three months. Consequently, whereas the mine figures represent the quantity of copper actually mined each calendar year, the smelter and refinery figures represent the quantity of copper produced during that year from ore part of which was mined near the end of the preceding calendar year. The differences among the three sets of figures, however, should not be very great for any single year when the industry is normal.

As the smelter statistics permit accurate geographic distribution as to source and also represent the actual production of the copper, they are adopted in this report as showing the production of the country. They include the production of blister copper and the furnace-refined or Lake copper.

## SUMMARY OF DOMESTIC AND WORLD STATISTICS.

*Summary of statistics of the copper industry in the United States, 1913 and 1918–1922.*

| | 1913 | 1918 | 1919 |
|---|---|---|---|
| Production of copper: | | | |
| Smelter output....pounds.. | 1,224,484,098 | 1,908,533,595 | 1,286,419,329 |
| Mine production....do.... | 1,235,569,727 | 1,910,022,841 | 1,212,334,041 |
| Refinery production of new copper— | | | |
| Electrolytic....do.... | 1,022,497,601 | 1,560,327,422 | 1,233,994,324 |
| Lake....do.... | 155,715,286 | 231,096,158 | 177,594,135 |
| Casting and pig....do.... | 58,611,026 | 91,450,611 | 21,897,336 |
| Total domestic....do.... | 1,236,823,913 | 1,882,874,191 | 1,433,485,795 |
| Total domestic and foreign....do.... | 1,615,067,782 | 2,432,385,290 | 1,805,306,801 |
| Total new and old copper....do.... | 1,888,000,000 | 3,138,000,000 | 2,380,000,000 |
| Ore produced: | | | |
| Copper ore....short tons.. | 36,336,682 | 62,289,069 | 36,121,622 |
| Average yield of copper....per cent.. | 1.67 | 1.51 | 1.65 |
| Average cost per pound of copper produced ....cents.. | 10.24 | 14.49 | 15.25 |
| Other ore yielding copper....short tons.. | 24,419 | 15,698 | 17,632 |
| Average price per pound....cents.. | 15.5 | 24.7 | 18.6 |
| Imports (unmanufactured)....pounds.. | 408,778,954 | 575,805,115 | 429,387,594 |
| Exports of metallic copper [a]....do.... | 926,241,092 | 744,243,481 | 515,595,019 |
| Withdrawn from total supply on domestic account: | | | |
| Total new copper....pounds.. | 812,268,639 | 1,661,669,576 | 914,471,572 |
| Total new and old copper....do.... | 1,085,000,000 | 2,367,000,000 | 1,489,000,000 |
| Stocks of refined copper [b]....do.... | 90,385,402 | 180,000,000 | 631,000,000 |
| Stocks of blister and materials in solution [b]....do.... | 247,789,811 | 562,600,000 | 273,000,000 |
| World's production....do.... | 2,181,253,000 | 3,148,499,000 | (c) |
| Value of production in the United States.... | $189,795,035 | $471,408,000 | $239,274,000 |

| | 1920 | 1921 | 1922 |
|---|---|---|---|
| Production of copper: | | | |
| Smelter output....pounds.. | 1,209,061,040 | 505,586,098 | 950,285,947 |
| Mine production....do.... | 1,224,550,151 | 466,190,853 | 964,583,894 |
| Refinery production of new copper— | | | |
| Electrolytic....do.... | 1,010,240,867 | 506,532,984 | 766,944,836 |
| Lake....do.... | 153,483,952 | 100,918,001 | 122,545,126 |
| Casting and pig....do.... | 18,698,421 | 1,963,271 | 15,180,723 |
| Total domestic....do.... | 1,182,423,240 | 609,414,256 | 904,670,685 |
| Total domestic and foreign....do.... | 1,634,908,644 | 1,020,027,096 | 1,358,659,101 |
| Total new and old copper....do.... | 2,260,000,000 | 1,455,000,000 | 2,030,000,000 |
| Ore produced: | | | |
| Copper ore....short tons.. | 36,765,370 | 13,396.382 | 26,893,247 |
| Average yield of copper....per cent.. | 1.63 | 1.70 | 1.74 |
| Average cost per pound of copper produced ....cents.. | 14.94 | (c) | (c) |
| Other ore yielding copper....short tons.. | 26,890 | 14,248 | 52,370 |
| Average price per pound....cents.. | 18.4 | 12.9 | 13.5 |
| Imports (unmanufactured)....pounds.. | 485,670,691 | 350,472,611 | 541,013,220 |
| Exports of metallic copper [a]....do.... | 623,158,489 | 628,415,714 | 742,755,957 |
| Withdrawn from total supply on domestic account: | | | |
| Total new copper....do.... | 1,053,838,558 | 610,988,744 | 896,633,833 |
| Total new and old copper....do.... | 1,679,000,000 | 1,046,000,000 | 1,568,000,000 |
| Stocks of refined copper [b]....do.... | 659,000,000 | 459,000,000 | 216,000,000 |
| Stocks of blister and materials in solution [b]....do.... | 465,000,000 | 283,000,000 | 361,000,000 |
| World's production....do.... | (c) | (c) | (c) |
| Value of production in the United States.... | $222,467,000 | $65,221,000 | $128,289,000 |

[a] Total exports of copper, exclusive of ore, concentrates, and composition metal.
[b] At the end of the year.
[c] Figures not yet available.

*Copper produced in the United States from domestic ores, 1913 and 1918–1922.*

[Smelter output, in pounds fine.]

| State. | 1913 | 1918 | 1919 | 1920 | 1921 | 1922 |
|---|---|---|---|---|---|---|
| Alaska | 23,423,070 | 67,081,648 | 56,534,992 | 66,093,924 | 76,808,114 | 59,900,579 |
| Arizona | 404,278,809 | 769,521,729 | 536,515,368 | 552,988,731 | 155,165,656 | 428,200,634 |
| California | 32,492,265 | 44,150,761 | 23,548,698 | 11,822,028 | 15,906,883 | 20,440,430 |
| Colorado | 9,052,104 | 7,591,570 | 4,892,558 | 4,282,616 | 6,592,598 | 3,635,916 |
| Georgia | | 397,078 | 8,306 | 3,663 | | 8,147 |
| Idaho | 8,711,490 | 5,836,795 | 3,966,655 | 1,922,116 | 1,971,623 | 3,504,944 |
| Maine | | 501,169 | 376,186 | | 3 | |
| Michigan | 155,715,286 | 231,096,158 | 177,594,135 | 153,483,952 | 100,918,001 | 122,545,126 |
| Missouri | 576,204 | 232,073 | 588,570 | 533,368 | 137,591 | 1,070,259 |
| Montana | 285,724,467 | 326,426,761 | 176,289,873 | 177,743,747 | 49,471,206 | 165,341,414 |
| Nevada | 85,209,536 | 106,266,603 | 64,683,734 | 55,580,322 | 15,129,116 | 20,398,611 |
| New Mexico | 50,196,881 | 96,559,580 | 60,377,320 | 52,159,751 | 18,076,909 | 29,127,329 |
| North Carolina | 180 | 79,200 | 3,334 | | | |
| Oregon | 77,812 | 2,630,499 | 2,808,017 | 2,529,311 | 274,934 | 925,954 |
| Pennsylvania | 245,337 | 34,500 | | 618,361 | | 888,721 |
| South Carolina | | | 2,297 | | | |
| South Dakota | | | 8,631 | 2,190 | | |
| Tennessee | 19,489,654 | 15,053,568 | 15,629,454 | 16,727,803 | 15,084,294 | 14,226,232 |
| Texas | 39,008 | 13,851 | 2,153 | 14,217 | 587 | 3,889 |
| Utah | 148,057,450 | 230,964,908 | 143,836,304 | 110,357,748 | 45,831,959 | 79,665,563 |
| Vermont | 5,771 | 896,630 | 582,561 | | | |
| Virginia | 46,961 | 1,248 | | | | |
| Washington | 732,742 | 2,330,568 | 2,552,134 | 2,125,586 | 598,658 | 369,133 |
| Wyoming | 362,235 | 866,698 | 150,051 | 24,256 | 9,830 | |
| Undistributed | 46,836 | | 15,467,998 | 47,350 | 3,608,136 | 33,066 |
| | 1,224,484,098 | 1,908,533,595 | 1,286,419,329 | 1,209,061,040 | 505,586,098 | 950,285,947 |

## GENERAL CONDITIONS.

The resumption of operations by the principal companies in 1922 resulted in a mine and smelter production about double that of 1921, but the refinery production of new copper exceeded that of the previous year by only about 33 per cent, because the new blister did not reach the refineries until the middle of the summer. In spite of the increase, however, the output was only about half of the average output of 1916, 1917, and 1918. Stocks were reduced to approximately the normal working quantity, and domestic consumption exceeded by about one-half that of 1921. A weak market and a low price characterized most of the year, and it was not until the last quarter that the market strengthened materially and the price increased. The better conditions continued through the first quarter of 1923, but thereafter both market and price weakened, and the condition of the industry is not greatly different this summer from last.

The increased consumption and price that marked the last quarter of 1922 and the first quarter of 1923 could not be maintained, as much of the buying was done to satisfy accumulated needs, and the export market for copper slowly but surely declined. Under the conditions now prevailing the excess producing capacity of the domestic industry is very large, and even the present low rate of production may result in some accumulation of stocks.

Statistics of production, consumption, and stocks indicate that the industry is on a sound marketing basis, which is being maintained by means of reduced operations, at a great cost to the industry and ultimately to the country as a whole. The copper price index based on pre-war conditions is only a little more than half that of labor and other commodities. This condition is resulting in the exhaustion of one of the country's basic wasting assets at a price that will purchase hardly more than one-half its equivalent in other commodities. Obviously both the country and the investor must ultimately suffer as a result, and national economics and conservation demand that the

situation be remedied. There is, however, little hope for immediate correction of this condition, and there can be no permanent improvement until the European situation is greatly changed and the copper industry is properly integrated into economically sound producing and fabricating units. It is only by such integration that the costly and unnecessary excess producing capacity can be economically conserved against future needs and the various intermediate profits can be eliminated, to the mutual advantage of the miner, the consumer, and the country. The problems of consolidation of producing and fabricating units, taxation, labor supply, costs, and foreign markets are fundamental, and their solution would inevitably be to the best interests of the country.

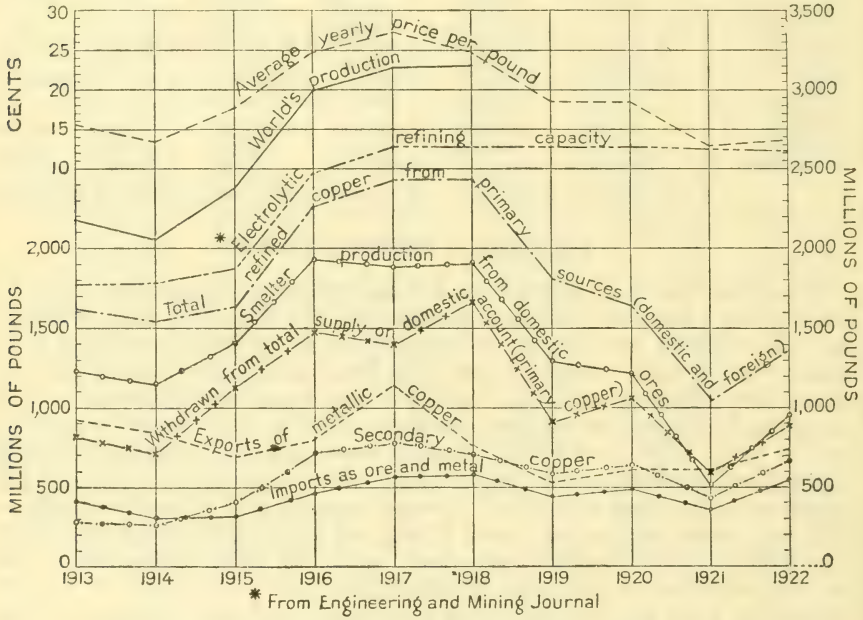


FIGURE 9.—Graphs showing the principal features of the copper industry, 1913–1922.

A strong hope for help in solving these problems lies in the United States Senate Commission of Gold and Silver Inquiry, under the chairmanship of Senator Oddie. This commission was created primarily to determine and analyze the problems of the precious-metals industry, but the precious metals are so largely derived from copper, lead, and complex copper-lead-zinc-gold-silver ores, and the great problems of each metal industry are so common to one or all of the other metals, that a thorough understanding of all is necessary to a thorough understanding of one. Accordingly the commission has determined to go to the roots of the problems of nonferrous base-metal mining by a thorough detailed analysis of the cost of production, the investment and yield on investment, the economic and financial relation of these industries to other industries and investments, and the part these metals play in the industrial life of the country. Cooperation between the companies and the commission must result in a sound basis for remedies of the present unsatisfactory conditions.

## PRODUCTION.

### SMELTER PRODUCTION.

The smelter production of copper from domestic ores increased from 505,586,098 pounds in 1921 to 950,285,947 pounds in 1922, or 88 per cent. The value of this output was $128,289,000, compared with $65,221,000 in 1921, an increase of 97 per cent. It should be borne in mind, however, that the production in 1921 represented the smallest production since 1897. The smelter production in 1922 was, next to that of 1921, smaller than that for any other year since 1908.

The figures of smelter production in 1922 are based on returns made confidentially to the United States Geological Survey by all known smelting companies handling copper-bearing materials from the United States. To all companies and officials who have aided in furnishing this information and have given valuable time to answering inquiries concerning distribution of the output sincere thanks are extended. The following list gives the names of the owning or operating companies, the location, and the final copper product of smelting and refining plants treating material from the United States during 1922. It does not include lead and zinc plants that recovered copper as a by-product from mixed ores. Lists of lead and zinc smelters can be found in the reports on those metals.

*Copper reduction plants that treated materials from the United States in 1922.*[a]

| Location. | Company. | Final copper product. |
|---|---|---|
| Arizona: | | |
| Ajo | New Cornelia Copper Co. | Electrolytic. |
| Clarkdale | United Verde Copper Co. | Blister. |
| Do. | United Verde Extension Mining Co. | Do. |
| Douglas | Calumet & Arizona Mining Co. | Do. |
| Do. | Phelps Dodge Corporation | Do. |
| Globe | Old Dominion Co. | Do. |
| Hayden | American Smelting & Refining Co. | Do. |
| Humboldt | Southwest Metals Co. | Do. |
| Miami | International Smelting Co. | Do. |
| Maryland: Baltimore | Baltimore Copper Smelting & Rolling Co. | Electrolytic. |
| Michigan: | | |
| Hancock | Quincy Mining Co. | Anodes and lake. |
| Houghton | Michigan Smelting Co. | Do. |
| Hubbell | Calumet & Hecla Mining Co. | Do. |
| Montana: | | |
| Anaconda | Anaconda Copper Mining Co. | Blister. |
| Butte | East Butte Copper Mining Co. | Do. |
| Great Falls | Anaconda Copper Mining Co. | Blister and electrolytic. |
| Nevada: McGill | Nevada Consolidated Copper Co. | Blister. |
| New Jersey: | | |
| Chrome | United States Metals Refining Co. | Blister and electrolytic. |
| Maurer | American Smelting & Refining Co. | Blister, electrolytic, and casting. |
| Newark | Balbach Smelting & Refining Co. | Casting. |
| Perth Amboy | Raritan Copper Works | Electrolytic and casting. |
| New York: Laurel Hill | Nichols Copper Co. | Blister, electrolytic, and casting. |
| Tennessee: | | |
| Copperhill | Tennessee Copper Co. | Blister. |
| Isabella | Ducktown Sulphur, Copper & Iron Co. (Ltd.). | Do. |
| Texas: El Paso | American Smelting & Refining Co. | Do. |
| Utah: | | |
| Garfield | Garfield Smelting Co. | Do. |
| International | International Smelting Co. | Do. |
| Virginia: West Norfolk | Norfolk Smelting Co. | Do. |
| Washington: Tacoma | American Smelting & Refining Co. | Blister and electrolytic. |

[a] This list does not include a smelter in Pennsylvania, which made blister from material solely of foreign origin.

During the year 29 copper smelting and refining plants treated material from the United States; all of these were domestic plants.

The figures of production represent the actual smelter recovery. For Michigan it is the sum of furnace-refined copper and copper cast into anodes for electrolytic refining. As to blister copper, the figures represent the fine copper content. Some casting and electrolytic copper is produced direct from ore or matte, and this is included in the smelter production. Metallic and cement copper recovered by leaching is also included in smelter production.

## MINE RETURNS.

The figures of mine production are based on reports furnished to the United States Geological Survey by all mines producing copper in 1922. These mines reported 964,583,894 pounds of copper.

The mines and smelters of several of the large copper producers are under the same management, and their production is reported on the same basis. The figures furnished by mines that ship to custom smelters or have only matting furnaces and ship their matte for conversion are likely to show considerable discrepancy from the smelter returns, as the mines may report a considerable quantity that has not reached the stage of blister copper by the end of the year and is consequently not included in the smelter production, or material that was reported by the mines in one year may be treated by the smelters in the following year. This discrepancy is more pronounced if a marked curtailment of production occurs at the beginning or the end of the year, so that there is not the balance of overlap that occurs if the industry is in normal condition throughout the year. Considerable copper is recovered by the smelters from ores that are treated primarily for other metals, the copper content being so low that it is not paid for and consequently is not always reported by the mines.

The difference between the smelter and the refinery production is accounted for entirely by an increase in the stocks of blister copper plus the copper content of bluestone produced and the loss in refining.

*Copper produced from domestic ores as reported by mines, smelters, and refineries, 1916–1922 in pounds.*

| Year. | Mine. | Smelter. | Refinery. |
|---|---|---|---|
| 1916 | 2,005,875,312 | 1,927,850,548 | 1,888,752,199 |
| 1917 | 1,895,434,349 | 1,886,120,721 | 1,873,546,171 |
| 1918 | 1,910,022,841 | 1,908,533,595 | 1,882,874,191 |
| 1919 | 1,212,334,041 | 1,286,419,329 | 1,433,485,795 |
| 1920 | 1,224,550,151 | 1,209,061,040 | 1,182,423,240 |
| 1921 | 466,190,853 | 505,586,098 | 609,414,256 |
| 1922 | 964,583,894 | 950,285,947 | 904,670,685 |

## PRODUCTION BY STATES.

Sixteen States and one Territory contributed to the smelter production of copper in 1922. The subjoined table shows the mine and the smelter output of individual States for 1921 and 1922.

According to smelter returns, the four leading States in 1922—Arizona, Montana, Michigan, and Utah—produced 84 per cent of the total output, as compared with 76 per cent from the four leading States in 1921; and the eight leading States, including the four

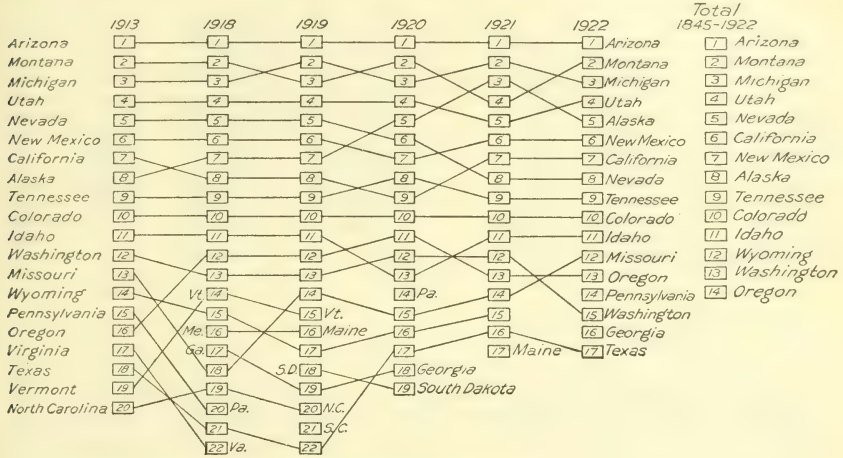


FIGURE 10.—Chart showing rank of States producing copper, 1913, 1918–1922, and 1845–1922.

named and Alaska, New Mexico, California, and Nevada, produced 97 per cent of the total output in 1922, compared with 95 per cent in 1921.

*Copper produced in the United States in 1921 and 1922, according to smelter and mine returns, by States, in pounds.*

| State. | 1921 | | 1922 | | | |
|---|---|---|---|---|---|---|
| | | | Smelter returns. | | | |
| | Smelter returns. | Mine returns. | Rank. | Percentage of total. | Quantity. | Mine returns. |
| Alaska | 76,808,114 | 57,011,597 | 5 | 6.30 | 59,900,579 | 77,967,819 |
| Arizona | 155,165,656 | 185,034,194 | 1 | 45.06 | 428,200,634 | 400,043,128 |
| California | 15,906,883 | 11,743,404 | 7 | 2.15 | 20,440,430 | 22,539,485 |
| Colorado | 6,592,598 | 4,153,442 | 10 | .38 | 3,635,916 | 3,373,454 |
| Georgia | | | 16 | | 8,147 | 6,000 |
| Idaho | 1,971,623 | 1,688,195 | 11 | .37 | 3,504,944 | 3,282,842 |
| Maine | 3 | | | | | |
| Michigan | 100,918,001 | 86,370,028 | 3 | 12.90 | 122,545,126 | 121,712,365 |
| Missouri | 137,591 | 137,591 | 12 | .11 | 1,070,259 | 797,400 |
| Montana | 49,471,206 | 48,098,730 | 2 | 17.40 | 165,341,414 | 165,754,442 |
| Nevada | 15,129,116 | 10,961,491 | 8 | 2.15 | 20,398,611 | 23,133,091 |
| New Mexico | 18,076,909 | 14,267,338 | 6 | 3.07 | 29,127,329 | 31,937,207 |
| Oregon | 274,934 | 174,300 | 13 | .10 | 925,954 | 1,046,525 |
| Pennsylvania | | 313,302 | 14 | .09 | 888,721 | 1,229,926 |
| Tennessee | 15,084,294 | 15,084,294 | 9 | 1.50 | 14,226,232 | 14,240,571 |
| Texas | 587 | | 17 | | 3,889 | 4,290 |
| Utah | 45,831,959 | 30,891,403 | 4 | 8.38 | 79,665,563 | 97,193,850 |
| Washington | 598,658 | 251,544 | 15 | .04 | 369,133 | 317,203 |
| Wyoming | 9,830 | 10,000 | | | | 4,296 |
| Undistributed | 3,608,136 | | | | 33,066 | |
| | 505,586,098 | 466,190,853 | | 100.00 | 950,285,947 | 964,583,894 |

*Copper produced in the United States, 1845–1922, by States.*

[Smelter output.]

| State. | Pounds. | Percentage. | Rank. |
|---|---|---|---|
| Alaska | 735,158,163 | 2.37 | 8 |
| Arizona | 8,929,126,567 | 28.75 | 1 |
| California | 816,625,483 | 2.63 | 6 |
| Colorado | 294,241,102 | .95 | 10 |
| Idaho | 117,955,559 | .38 | 11 |
| Michigan | 7,083,923,230 | 22.81 | 3 |
| Montana | 8,226,735,885 | 26.49 | 2 |
| Nevada | 977,907,045 | 3.15 | 5 |
| New Mexico | 745,330,724 | 2.40 | 7 |
| Oregon | 16,475,848 | .05 | 14 |
| Tennessee | [a] 412,779,000 | 1.33 | 9 |
| Utah | 2,488,228,524 | 8.01 | 4 |
| Washington | 18,064,203 | .06 | 13 |
| Wyoming | 31,585,120 | .10 | 12 |
| Other States and unapportioned | 163,805,064 | .52 | ..... |
| | 31,057,941,517 | 100.00 | ..... |

[a] Approximate production.

The three States that have made the largest production are Arizona, Montana, and Michigan. These three States together have produced about 78 per cent of the output of the United States.

*Mine production of copper in the principal districts in 1922.*

| District or region. | State. | Mine output (pounds). | Percentage of total production. | Rank. |
|---|---|---|---|---|
| Globe-Miami | Arizona | 170,035,000 | 17.63 | 1 |
| Butte | Montana | 165,374,000 | 17.14 | 2 |
| Lake Superior | Michigan | 121,712,000 | 12.62 | 3 |
| Bingham | Utah | 91,762,000 | 9.51 | 4 |
| Bisbee | Arizona | 79,591,000 | 8.25 | 5 |
| Jerome | do | 74,794,000 | 7.75 | 6 |
| Copper River | Alaska | 59,944,000 | 6.21 | 7 |
| Santa Rita (Central) | New Mexico | 28,408,000 | 2.95 | 8 |
| Ray | Arizona | 27,960,000 | 2.90 | 9 |
| Ajo | do | 26,613,000 | 2.76 | 10 |
| Ely (Robinson) | Nevada | 22,615,000 | 2.34 | 11 |
| Plumas | California | 20,678,000 | 2.14 | 12 |
| Prince William Sound | Alaska | 17,585,000 | 1.82 | 13 |
| Ducktown | Tennessee | 14,241,000 | 1.48 | 14 |
| Morenci-Metcalf | Arizona | 14,175,000 | 1.47 | 15 |
| Planet | do | 3,666,000 | .38 | 16 |
| Lordsburg | New Mexico | 3,217,000 | .33 | 17 |
| Tintic | Utah | 2,295,000 | .24 | 18 |
| Alder Creek | Idaho | 1,846,000 | .19 | 19 |
| Shasta County | California | 1,733,000 | .18 | 20 |
| Big Bug | Arizona | 1,530,000 | .16 | 21 |
| Park City | Utah | 1,443,000 | .15 | 22 |
| Lebanon (Cornwall mine) | Pennsylvania | 1,230,000 | .13 | 23 |
| Baker County | Oregon | 1,041,000 | .11 | 24 |

As shown in this table, 24 districts in 1922 each produced 1,000,000 pounds or more of copper.

In the following table the statistics for the later years are compiled from mine reports furnished to the United States Geological Survey by the producing companies, and those for the earlier years are taken mainly from reports on the several districts by members of the Survey:

*Copper produced in the principal districts to the end of 1922.*

| District. | State. | Date production began. | Pounds. | Per cent. | Rank. |
|---|---|---|---|---|---|
| Butte | Montana | 1868 | 8,180,382,000 | 26.34 | 1 |
| Lake Superior | Michigan | 1845 | 7,053,885,000 | 22.71 | 2 |
| Bisbee | Arizona | 1880 | 2,905,210,000 | 9.35 | 3 |
| Bingham | Utah | 1896 | 2,156,853,000 | 6.94 | 4 |
| Globe-Miami | Arizona | 1881 | 1,868,340,000 | 6.02 | 5 |
| Morenci-Metcalf | do | 1873 | 1,528,272,000 | 4.92 | 6 |
| Jerome | do | 1883 | 1,415,899,000 | 4.56 | 7 |
| Ely (Robinson) | Nevada | 1908 | 849,281,000 | 2.73 | 8 |
| Santa Rita (Central) | New Mexico | 1800 | 655,191,000 | 2.11 | 9 |
| Ray (Mineral Creek) | Arizona | 1911 | 613,407,000 | 1.98 | 10 |
| Shasta County | California | 1897 | 575,652,000 | 1.85 | 11 |
| Ducktown | Tennessee | 1850 | 412,794,000 | 1.33 | 12 |
| Tintic | Utah | 1880 | 156,644,000 | .50 | 13 |
| Foothill belt | California | 1862 | 155,045,000 | .50 | 14 |

Fourteen districts in eight States have each contributed in excess of 150,000,000 pounds to the copper output of the country. Five of these districts are in Arizona, two each in California and Utah, and one each in Montana, Michigan, Nevada, New Mexico, and Tennessee. Two districts stand out prominently. They are the Butte district, Mont., which has produced 26.34 per cent of the output of the country, and the Lake Superior district, Mich., which has produced 22.71 per cent of the total output. Bisbee, ranking third, has yielded 9.35 per cent of the total. The 14 districts have yielded 91.84 per cent of the total output of the United States since 1845.

## QUANTITY AND ESTIMATED RECOVERABLE CONTENT OF COPPER-BEARING ORES.

The following tables show the quantity and the estimated recoverable content in copper of the ore produced by the mines of the United States in 1922. The figures are taken from the mine reports in Mineral Resources. The close agreement between the output as reported by the smelters and the recoverable quantity as reported by the mines indicates that the estimated recoverable tenor is very close to the actual recovery. The classification of some of the complex western ores is difficult and more or less arbitrary. Under copper ores are classed not only those which contain 2.5 per cent or more of copper but those which contain less than this percentage if their principal value is in copper. Under copper-lead and copper-zinc ores are classed complex ores in which copper is a valuable constituent. Considerable copper was reported by the mines from ores mined primarily for other metals, including siliceous gold and silver ores, lead ores, zinc ores, pyritic sulphur ores, and ores concentrated for their content of other metals. No attempt has been made to compile tables showing the quantity and recoverable content of this group of copper-bearing ores, but together with old slags and other materials they yielded a total of 27,380,657 pounds of copper.

*Copper produced in the United States in 1922 from ores in which copper constitutes the principal value.*

| State. | Copper ore (short tons). | Copper in ore. | | Gold in ore (fine ounces). | Silver in ore (fine ounces). | Value in gold and silver per ton. |
|---|---|---|---|---|---|---|
| | | Pounds. | Percentage. | | | |
| Alaska | 581,384 | 77,967,469 | 6.71 | 729 | 623,518 | $1.10 |
| Arizona | 10,431,729 | [a] 399,014,848 | 1.91 | 57,745 | 2,766,277 | .38 |
| California | 447,200 | 21,845,111 | 2.44 | 5,729 | 320,977 | .98 |
| Colorado | 863 | 105,864 | 6.13 | 556 | 31,463 | 49.78 |
| Idaho | 32,590 | 2,572,335 | 3.95 | 2,046 | 44,550 | 2.66 |
| Michigan | 4,952,264 | 121,712,365 | 1.23 | ..... | 376,990 | .27 |
| Montana | 3,250,213 | [a] 152,823,229 | 2.35 | 13,367 | 5,446,684 | 1.76 |
| Nevada | 629,408 | [a] 22,452,852 | 1.78 | 4,401 | 17,127 | .17 |
| New Mexico | 1,477,166 | 31,669,547 | 1.07 | 6,806 | 111,624 | .17 |
| Oregon | 17,117 | 1,012,189 | 2.96 | 2,772 | 14,405 | 4.19 |
| Tennessee | 557,750 | 14,240,571 | 1.28 | 209 | 78,341 | .15 |
| Texas | 73 | 4,290 | 2.94 | ..... | 377 | 5.16 |
| Utah | [b] 4,509,380 | [a b] 90,523,462 | 1.00 | 36,399 | 473,284 | .27 |
| Washington | 6,086 | 312,912 | 2.57 | 38 | 68,239 | 11.34 |
| Wyoming | 24 | 4,296 | 8.95 | 6 | 52 | 7.33 |
| Total and average | 26,893,247 | 936,261,340 | 1.74 | 130,803 | 10,373,908 | .49 |

[a] Exclusive of copper recovered as precipitates from mine waters, as follows: Arizona, 249,343 pounds; Montana, 10,037,514 pounds; Nevada, 187,190 pounds; Utah, 563,718 pounds.
[b] Exclusive of 4 tons of slag, containing 827 pounds of copper.

*Copper ores concentrated, smelted, and leached and copper produced from each class of ore in the United States in 1922.*

| State. | Ore concentrated. | | | |
|---|---|---|---|---|
| | Short tons. | Concentrates produced (short tons). | Copper in concentrates (pounds). | Percentage of copper. |
| Alaska | 544,212 | 53,572 | 48,423,640 | 4.45 |
| Arizona | 7,617,726 | 470,045 | 202,095,491 | 1.33 |
| California | 431,601 | 39,167 | 19,890,598 | 2.30 |
| Idaho | 15,776 | 1,566 | 708,291 | 2.24 |
| Michigan | 4,952,264 | [a] 96,992 | [b] 121,712,365 | 1.23 |
| Montana | 3,132,253 | 858,714 | 142,465,556 | 2.27 |
| Nevada | 518,523 | 48,084 | 9,745,733 | .94 |
| New Mexico | 1,416,869 | 64,340 | 28,406,314 | 1.00 |
| Oregon | 15,070 | 3,570 | 813,869 | 2.70 |
| Tennessee | 138,440 | 11,962 | 2,803,994 | 1.01 |
| Utah | 4,471,711 | 202,801 | 88,098,018 | .99 |
| Washington | 4,525 | 328 | 78,284 | .87 |
| Total and average | 23,258,970 | 1,851,141 | 665,242,153 | 1.43 |

| State. | Ore leached.[c] | | | Ore smelted. | | |
|---|---|---|---|---|---|---|
| | Short tons. | Copper produced (pounds). | Percentage of copper. | Short tons. | Copper produced (pounds). | Percentage of copper. |
| Alaska | ..... | ..... | ..... | 37,172 | 29,543,829 | 39.74 |
| Arizona | 1,356,230 | 26,956,325 | 0.99 | 1,457,773 | 169,963,032 | 5.83 |
| California | ..... | ..... | ..... | 15,599 | 1,954,513 | 6.26 |
| Colorado | ..... | ..... | ..... | 863 | 105,864 | 6.13 |
| Idaho | ..... | ..... | ..... | 16,814 | 1,864,044 | 5.54 |
| Montana | ..... | ..... | ..... | 117,960 | 10,357,673 | 4.39 |
| Nevada | ..... | ..... | ..... | 110,885 | 12,707,119 | 5.73 |
| New Mexico | ..... | ..... | ..... | 60,297 | 3,263,233 | 2.71 |
| Oregon | ..... | ..... | ..... | 2,047 | 198,320 | 4.84 |
| Tennessee | ..... | ..... | ..... | 419,310 | 11,436,577 | 1.36 |
| Texas | ..... | ..... | ..... | 73 | 4,290 | 2.94 |
| Utah | ..... | ..... | ..... | 37,669 | 2,425,444 | 3.22 |
| Washington | ..... | ..... | ..... | 1,561 | 234,628 | 7.52 |
| Wyoming | ..... | ..... | ..... | 24 | 4,296 | 8.95 |
| Total and average | 1,356,230 | 26,956,325 | .99 | 2,278,047 | 244,062,862 | 5.36 |

[a] Includes concentrates from sands.
[b] Includes copper from sands.
[c] Does not include old tailings treated.

*Copper produced from copper-lead and copper-zinc ores in the United States in 1922.*

| State. | Copper-lead and copper-zinc ores (short tons). | Copper in ore (pounds). | Percentage of copper. |
|---|---|---|---|
| Arizona | 435 | 25,280 | 2.91 |
| California | 47 | 4,138 | 4.40 |
| Colorado | 627 | 60,299 | 4.81 |
| Georgia | 600 | 6,000 | .50 |
| Idaho | 26,143 | 292,095 | .56 |
| Montana | 21,251 | 204,497 | .48 |
| Nevada | 102 | 11,283 | 5.53 |
| New Mexico | 1,893 | 213,072 | 5.63 |
| Utah | 1,272 | 125,233 | 4.92 |
| Total and average | 52,370 | 941,897 | .90 |

*Copper derived from ores classed as copper-bearing (copper, copper-lead, and copper-zinc ores), and total production of copper from all sources in the United States in 1922.*

| State. | Ore treated (short tons). | Copper recovered (pounds). | Percentage of copper. | Copper from all sources, including old slags, smelter cleanings, and precipitates (pounds). |
|---|---|---|---|---|
| Alaska | 581,384 | 77,967,469 | 6.71 | 77,967,819 |
| Arizona[a] | 10,432,164 | 399,040,128 | 1.91 | 400,043,128 |
| California | 447,247 | 21,849,249 | 2.44 | 22,539,485 |
| Colorado[b] | 1,490 | 166,163 | 5.58 | 3,373,454 |
| Georgia | 600 | 6,000 | .50 | 6,000 |
| Idaho | 58,733 | 2,864,430 | 2.44 | 3,282,842 |
| Michigan | 4,952,264 | 121,712,365 | 1.23 | 121,712,365 |
| Missouri | ..... | ..... | ..... | 797,400 |
| Montana[c] | 3,271,464 | 153,027,726 | 2.34 | 165,754,442 |
| Nevada | 629,510 | 22,464,135 | 1.78 | 23,133,091 |
| New Mexico[d] | 1,479,059 | 31,882,619 | 1.08 | 31,937,207 |
| Oregon | 17,117 | 1,012,189 | 2.96 | 1,046,525 |
| Pennsylvania | ..... | ..... | ..... | 1,229,926 |
| Tennessee | 557,750 | 14,240,571 | 1.28 | 14,240,571 |
| Texas | 73 | 4,290 | 2.94 | 4,290 |
| Utah | 4,510,652 | 90,648,695 | 1.00 | 97,193,850 |
| Washington | 6,086 | 312,912 | 2.57 | 317,203 |
| Wyoming | 24 | 4,296 | 8.95 | 4,296 |
| Total and average | 26,945,617 | 937,203,237 | 1.74 | 964,583,894 |

[a] A quantity of copper was recovered from old slags and ores not classed as copper ores.
[b] Most of the copper from Colorado is derived from ores classed as siliceous ores and lead ores.
[c] Considerable copper was recovered as precipitates from mine waters and from ores not classed as copper ores.
[d] A quantity of copper was derived from ores classed as lead ores and siliceous ores.

*Copper ores produced in the United States, 1917–1922, and average yield in copper, gold, and silver.*

| Year. | Smelting ores. | | Concentrating ores. | | Total. | | | | |
|---|---|---|---|---|---|---|---|---|---|
| | Short tons. | Yield in copper (per cent). | Short tons. | Yield in copper (per cent). | Short tons. | Yield in copper (per cent). | Yield per ton in gold (ounce). | Yield per ton in silver (ounce). | Value per ton in gold and silver. |
| 1917 | 7,438,068 | 4.39 | 51,044,626 | 1.19 | 58,482,694 | 1.60 | 0.0058 | 0.347 | $0.49 |
| 1918 | 6,223,674 | 4.51 | 53,937,796 | 1.18 | 62,289,069 | 1.51 | .0050 | .328 | .50 |
| 1919 | 3,465,880 | 4.64 | 30,769,966 | 1.35 | 36,121,622 | 1.65 | .0052 | .356 | .51 |
| 1920 | 3,200,509 | 4.89 | 31,348,340 | 1.34 | 36,765,370 | 1.63 | .0047 | .331 | .46 |
| 1921 | 1,235,602 | 4.77 | 11,022,544 | 1.44 | 13,396,382 | 1.70 | .0039 | .357 | .44 |
| 1922 | 2,278,047 | 5.36 | 23,258,970 | 1.43 | 26,893,247 | 1.74 | .0049 | .386 | .49 |

As usual, Arizona was the largest producer of copper ore, followed in order by Michigan, Utah, and Montana. Arizona was also the largest producer of copper from copper ore, followed by Montana, Michigan, Utah, and Alaska. In the output of smelting ores Arizona ranks first, followed in order by Tennessee, Montana, Nevada, and New Mexico, and in the output of concentrating ores Arizona stands first, followed by Michigan, Utah, Montana, New Mexico, and Alaska.

The estimated average recoverable content of copper in copper ore in 1922 was 1.74 per cent, compared with 1.70 per cent in 1921 and 1.63 per cent in 1920. The average yield from smelting ores increased from 4.77 per cent in 1921 to 5.36 per cent in 1921, and that of concentrating ores decreased from 1.44 per cent to 1.43 per cent.

Of the principal copper-producing States, Alaska showed the highest recoverable content of copper from ore, followed in order by Montana, Arizona, Michigan, and Utah. Of the States producing smelter ore in large quantity, Arizona had the highest recoverable content, followed by Nevada, Montana, New Mexico, and Tennessee. Of the States producing concentrating ores in large quantity, Alaska had the highest recoverable content, followed by Montana, Arizona, Michigan, New Mexico, and Utah.

Of the 52,370 tons of copper-lead and copper-zinc ores produced in 1922, Idaho and Montana furnished 47,394 tons.

The average value of the gold and silver recovered from copper ores in 1922 was 49 cents a ton. This compares with 44 cents in 1921 and 46 cents in 1920. Among the principal copper-producing States, Montana was first in the average yield of gold and silver, followed by Alaska and Arizona, with Michigan and Utah tying for fourth place.

## REVIEW BY COMPANIES AND STATES.

### SCOPE OF DISCUSSION.

In the following pages a brief statement of the conditions affecting production in the principal copper districts of the country is presented, and the tenor of the ore from each district is given, so far as it does not disclose the production of those individual companies whose figures of output have not already been published in their annual reports or elsewhere. More detailed information on the mining operations of the districts is given in the reports on mine production.

Figures of metal output, ore reserves, metal content, and recovery in treatment of individual companies given in this report, unless otherwise stated, are quoted from the published official reports of the companies. The chapter on copper in Mineral Resources for 1915 contains a map showing the location of the copper-producing districts and the metallurgic plants and also a brief discussion of the geologic occurrence of the ores in the different districts. Copies of that report may be obtained on application to the Director of the Geological Survey.

The American Smelting & Refining Co., whose operations are country-wide, reports the following net earnings for each quarter of 1922 before deducting depreciation, depletion, bond interest, and preferred stock dividends, but after deducting all taxes: First, $2,426,408; second, $2,986,627; third, $3,364,352; fourth, $4,385,504.

The year's volume of business nearly reached the volume handled in the pre-war year 1913. During the last half of 1922, it is reported, the rate of production was greater than during 1913.

*Operations of the American Smelting & Refining Co., 1914, 1921, and 1922.*

| | 1914 | 1921 | 1922 |
|---|---|---|---|
| *Production.* | | | |
| Gold.....ounces.. | 2,540,911 | 1,780,205 | 1,744,550 |
| Silver.....do.... | 77,604,483 | 75,354,443 | 84,793,931 |
| Platinum and palladium.....do.... | 1,664 | 863 | 1,165 |
| Lead.....short tons.. | 316,591 | 207,612 | 252,898 |
| Copper.....pounds.. | 529,686,000 | 348,888,000 | 433,548,000 |
| Zinc.....do.... | 15,748,000 | 14,628,614 | 35,040,000 |
| Nickel.....do.... | 356,187 | 120,080 | 314,586 |
| Tin.....do.... | ..... | 11,915,954 | 3,766,000 |
| Sulphuric acid.....do.... | 24,296,000 | 9,952,000 | 28,494,000 |
| Arsenic.....do.... | 6,184,000 | 5,155,522 | 11,203,052 |
| Copper sulphate.....do.... | 6,798,000 | 2,237,471 | 2,274,000 |
| By-product metals.....do.... | 1,678,228 | 3,232,488 | 12,700,577 |
| Sulphur dioxide.....do.... | ..... | 154,794 | 1,611 |
| *Operating statistics.* | | | |
| Number of men employed exclusive of Mexico and South America..... | 12,179 | 7,426 | 8,994 |
| Total wages and salaries..... | $10,212,591 | $11,205,547 | $12,981,167 |
| Average wage per day..... | $2.33 | $4.19 | $4.01 |
| Charge smelted.....short tons.. | 4,171,258 | 2,583,142 | 3,845,849 |
| Bullion refined.....do.... | 588,718 | 357,062 | 477,890 |
| Coal used.....do.... | 544,619 | 302,924 | 300,556 |
| Coke used.....do.... | 447,761 | 263,384 | 376,045 |
| Fuel oil used.....barrels.. | 976,528 | 758,937 | 1,145,212 |
| Gas used.....cubic feet.. | 7,430,300 | 837,012,321 | 1,684,226,523 |
| Ore mined.....short tons.. | 1,266,702 | 2,205,537 | 2,738,463 |
| Coal mined.....do.... | 257,942 | 360,952 | 460,144 |
| Coke produced.....do.... | 129,650 | 100,860 | 126,968 |

New mining properties in Mexico and South America were acquired by this company in 1922. During this year also arrangements were completed for the dissolution of the American Smelters Securities Co.

## ALASKA.

Alaska began to produce copper in notable quantity in 1903 and has since been a steady contributor. The total smelter production through 1922 has been 735,158,163 pounds of copper, representing 2.37 per cent of the total for the country and giving Alaska eighth rank among the copper-producing States. In 1922 Alaskan ores and concentrates yielded 59,900,579 pounds of blister copper, representing 6.30 per cent of the total for the country and giving Alaska fifth rank among the copper-producing States. In 1921 Alaska ranked third, with a production of approximately 15 per cent of the total for the country.

*Ketchikan district.*—In 1922 the Ketchikan district produced 2,066 tons of ore, from which 438,120 pounds of copper was obtained, compared with 2,107 tons of ore and 468,202 pounds of copper in 1921.

*Prince William Sound.*—The copper production of the Prince William Sound district increased from 5,276,680 pounds in 1921 to 17,585,000 pounds in 1922. Besides the copper, the 274,863 tons of ore treated yielded 65,437 ounces of silver. The Beatson mine of the

Kennecott Copper Corporation operated at about 50 per cent capacity throughout the year. A total of 274,863 tons of ore assaying 1.88 per cent of copper, which produced 23,147 tons of concentrates assaying 18.99 per cent of copper, was treated at the mill. The recovery was 85.15 per cent, against 85.92 per cent in 1921, but the company states that the higher grade of concentrates produced more than offset this decrease. The concentrates produced in 1922 assayed 18.99 per cent of copper, compared with 15.33 per cent in 1921.

*Copper River district.*—As usual, the Bonanza and Jumbo mines of the Kennecott Copper Corporation were the largest producers in the Copper River district, producing 205,616 tons of ore averaging 9.15 per cent of copper, compared with 229,809 tons averaging 7.66 per cent of copper in 1921. A total of 182,767 tons of ore was milled, assaying 6.47 per cent of copper, from which 18,777 tons of concentrates of an average assay of 49.03 per cent of copper were produced. The mill recovery increased from 77.82 per cent in 1921 to 78.88 per cent in 1922, owing to the more favorable ore treated during the last eight months of the year. Milling costs decreased from 71.9 cents a ton in 1921 to 70.6 cents a ton in 1922. The leaching plant treated 217,359 tons of mill tailings assaying 0.90 per cent of carbonate copper and produced 1,976.78 tons of precipitates containing 2,970,400 pounds of copper. The leaching recovery was 75.61 per cent, compared with 76.56 per cent in 1921. The total recovery of copper in all ores treated by milling and leaching was 87.29 per cent in 1922, compared with 86.07 per cent in 1921. Receipts at the smelter during the year amounted to 44,193,588 pounds of deliverable refined copper and 413,093 ounces of returnable silver. An average price of 13.605 cents a pound was received during the year from the sale of 63,608,194 pounds of copper. The cost of producing copper for the year, delivered to consumer, after charging in depreciation and taxes and crediting silver, amounted to 8.67 cents a pound. The corporation reports that sales during the year were approximately 45 per cent higher than production and that no refined copper was left unsold at the end of the year. On December 5, 1922, a cash distribution of 75 cents a share was declared, payable January 15, 1923.

## ARIZONA.

Inclusive of 1922 Arizona has made a total smelter production of 8,929,126,567 pounds of copper and ranks first among the copper-producing States of the country, having produced 28.75 per cent of the total. In 1922 Arizona produced 428,200,634 pounds of copper, representing 45.06 per cent of the total for the country, compared with 155,165,656 pounds, or 31 per cent of the total, in 1921, a very abnormal year.

*Bisbee district.*—In 1922 the Bisbee district produced 79,591,000 pounds of copper and thus ranked fifth among the copper-producing districts of the country. Inclusive of 1922 this district has made a total production of 2,905,210,000 pounds of copper and ranks third among the copper-producing districts, having produced 9.35 per cent of the total.

*Copper produced in Bisbee district, Ariz., 1917–1922.*

| Year. | Pounds. | Average yield in copper (per cent). | Value in gold and silver per ton. |
|---|---|---|---|
| 1917 | 167,600,000 | 5.0 | $1.56 |
| 1918 | 160,456,000 | 4.9 | 1.62 |
| 1919 | 122,311,000 | 4.87 | 2.21 |
| 1920 | 118,448,000 | 4.06 | 1.81 |
| 1921 | 37,249,000 | 4.81 | 3.00 |
| 1922 | 79,591,000 | 5.15 | 3.25 |

In 1922 the Copper Queen branch, of the Phelps Dodge Corporation, which was as usual the largest producer in the Bisbee district, produced 47,962,123 pounds of copper, as compared with 30,610,173 pounds in 1921. The quantity of copper delivered abroad in 1922 was considerably greater than in 1921, but the proportion of foreign sales to the total was less. In 1922 a total of 151,836,758 pounds of copper was sold and delivered at an average price of 13.34 cents a pound net cash f. o. b. New York. Of this total 99,861,185 pounds went to domestic trade and 51,975,573 pounds to foreign trade. In addition 12,107,633 pounds, part of the balance of the metal taken over with the properties of the Arizona Copper Co. (Ltd.), was sold by the United Metals Selling Co. for the account of the Phelps Dodge Corporation. A contract was made with the American Smelting & Refining Co. in 1922 for the refining of blister copper at its Perth Amboy plant on a toll basis, with the option of leasing and operating the refinery itself if this were deemed desirable. Ore production was resumed in February, 1922, and in order to operate on the most efficient basis, mining was restricted principally to the Southwest and Sacramento divisions. Production at the Douglas reduction works was also resumed in February. Here the output was limited during the first few months to 6,000,000 pounds a month but increased later to between 8,000,000 and 10,000,000 pounds. An increase of 10 per cent in wages became effective October 1. In 1922 the Copper Queen branch paid $715,033.58 in State, county, and city taxes, which amounted to $1.84 per ton of ore mined during the year, or to 1.49 cents per pound of copper.

*Metals produced by Copper Queen Consolidated Mining Co., 1918–1922.*

| Year. | Ore. | Copper. | Silver. | Gold. | Lead. | Zinc. |
|---|---|---|---|---|---|---|
| | *Short tons.* | *Pounds.* | *Ounces.* | *Ounces.* | *Pounds.* | *Pounds.* |
| 1918 | 771,063 | 90,988,156 | 558,433 | 16,409 | 1,234,497 | ..... |
| 1919 | 606,386 | 68,614,002 | 492,326 | 10,813 | 9,372 | ..... |
| 1920 | 832,172 | 71,443,396 | 486,698 | 8,846 | 243,836 | ..... |
| 1921 | 515,632 | 30,610,173 | 495,179 | 4,650 | 4,916,418 | ..... |
| 1922 | 389,367 | 47,962,123 | 1,132,304 | 11,972 | 8,560,525 | 247,793 |

The production of the Copper Queen branch of the Phelps Dodge Corporation, as summarized in the company's report, is as follows:

*Metals produced by Copper Queen branch of Phelps Dodge Corporation, 1922.*

**Production of mines.**

| | Ore, dry weight. | Gold. | Silver. | Copper. | Lead. | Zinc. |
|---|---|---|---|---|---|---|
| Underground: | *Short tons.* | *Ounces.* | *Ounces.* | *Pounds.* | *Pounds.* | *Pounds.* |
| Copper | 323,185 | 7,846 | 597,019 | 43,615,027 | ..... | ..... |
| Silver lead | 36,339 | 2,741 | 522,719 | 287,031 | 8,440,038 | ..... |
| Lead zinc | 456 | ..... | ..... | ..... | 120,487 | 247,793 |
| Total underground | 359,980 | 10,587 | 1,119,738 | 43,902,058 | 8,560,525 | 247,793 |
| Sacramento Hill: | | | | | | |
| High grade | 28,913 | 1,374 | 12,483 | 3,781,358 | ..... | ..... |
| Low grade | 127 | 11 | 62 | 16,241 | ..... | ..... |
| Total Sacramento Hill | 29,040 | 1,385 | 12,545 | 3,797,599 | ..... | ..... |
| Precipitates | 347 | ..... | 21 | 262,466 | ..... | ..... |
| Total production | 389,367 | 11,972 | 1,132,304 | 47,962,123 | 8,560,525 | 247,793 |

**Production of reduction works.**

| | Ore charged. | Gold. | Silver. | Copper. |
|---|---|---|---|---|
| | *Short tons.* | *Ounces.* | *Ounces.* | *Pounds.* |
| Copper Queen branch | 416,649 | 9,652 | 625,871 | 51,905,150 |
| Burro Mountain branch | 7,784 | 39 | 9,881 | 2,629,382 |
| Morenci branch | 68,958 | 826 | 36,786 | 13,137,565 |
| Moctezuma Copper Co. | 80,104 | 1,604 | 293,796 | 17,666,775 |
| Calumet & Arizona Co. exchange ore | 36,033 | 1,761 | 59,702 | 2,095,950 |
| Bunker Hill | 17,542 | 1,289 | 277,285 | 150,183 |
| All other | 22,538 | 1,262 | 145,653 | 1,691,149 |
| | 649,608 | 16,433 | 1,448,974 | 89,276,154 |
| Year (1921) | 201,164 | 4,630 | 442,635 | 27,591,174 |

Copper production at the smelter of the Calumet & Arizona Mining Co. was resumed February 5. At this time there was 108,000 tons of ore on the beds, which enabled the smelter to maintain a uniform production during the remainder of the year. The company reports that without this reserve it would have been exceedingly difficult to do this, owing to the decidedly inadequate supply of skilled miners. Wages were increased 10 per cent October 1. The annual report of the company states that State and county taxes were 26 per cent less than in 1921 but are still double the amounts levied in pre-war years. Commodity freight rates were decreased an average of 12 per cent. Class rates were also decreased 10 per cent. The freight rates, however, are said to be still from 25 to 70 per cent in excess of the rates in effect in 1916. The company sold 46,630,206 pounds of copper in 1922, at an average price of 13.61077 cents a pound. The value of precious metals per ton of refined copper from the company's ores averaged $70.96. An average of 714 men were employed in all departments at the mines in 1922, compared with 578 in 1921. A total of 358,905 tons of ore was mined in 1922. The average grade of the ore shipped to the Calumet & Arizona smelter, together with exchange ore shipped to the Copper Queen smelter, was 4.76 per cent, compared with 4.79 per cent in 1921.

*Metals produced by Calumet & Arizona Mining Co., 1918–1922.*

| Year. | Refined copper produced. | Gold. | Silver. | Dividends. |
|---|---|---|---|---|
| | *Pounds.* | *Ounces.* | *Ounces.* | |
| 1918 | 50,909,373 | 31,308 | 906,210 | $5,140,062 |
| 1919 | 44,991,107 | 28,530 | 995,366 | 1,927,563 |
| 1920 | 42,430,847 | 32,520 | 932,489 | 2,570,084 |
| 1921 | 17,855,613 | 12,365 | 419,647 | 1,285,043 |
| 1922 | 30,830,615 | 23,349 | 642,174 | 1,285,047 |

The property of the Shattuck Arizona Copper Co. was idle during the entire year 1922 except for development work, which was begun in June. At the end of the year the mine was being prepared for lead production, and the directors believed that copper production would follow quickly.

*Metals produced by Shattuck Arizona Copper Co., 1917–1921.*

| Year. | Copper. | Silver. | Gold. | Lead. | Copper recovered. | Dividends. |
|---|---|---|---|---|---|---|
| | *Pounds.* | *Ounces.* | *Ounces.* | *Pounds.* | *Per cent.* | |
| 1917 | 11,935,317 | 154,344 | 1,542 | 2,010,145 | 4.57 | $612,500 |
| 1918 | 9,081,959 | 161,230 | 1,220 | 2,420,690 | 4.83 | 437,500 |
| 1919 | 2,111,841 | 89,724 | 300 | 4,432,655 | 4.74 | [a] 262,500 |
| 1920 | 2,374,148 | 73,718 | 575 | 8,254,603 | 6.19 | ..... |
| 1921 [b] | 287,928 | 12,093 | 29 | ..... | 7.94 | ..... |

[a] Capital distribution through 1922 to the amount of $1,487,500.
[b] Result of development work only. No productive operations carried on.

*Globe-Miami district.*—Inclusive of 1922, the Globe-Miami district has produced 1,868,340,000 pounds of copper, which represents 6.02 per cent of the total output of the United States since 1845. The district ranks fifth in the country and second in the State. The Miami part of the district did not make a notable output until 1911.

*Copper produced in Globe-Miami district, Ariz., 1916–1922.*

| Year. | Copper. | Yield of ore in copper. | Year. | Copper. | Yield of ore in copper. |
|---|---|---|---|---|---|
| | *Pounds.* | *Per cent.* | | *Pounds.* | *Per cent.* |
| 1916 | 220,000,000 | 1.43 | 1920 | 176,215,000 | 1.20 |
| 1917 | 169,490,000 | 1.42 | 1921 | 76,488,000 | 1.33 |
| 1918 | 201,806,000 | 1.31 | 1922 | 170,035,000 | 1.36 |
| 1919 | 171,106,000 | 1.36 | | | |

The Old Dominion Co. sold 24,003,623 pounds of refined copper in 1922, at an average price of 13.353 cents a pound. The company states that in spite of low production in the first few months and high repair costs, due to deterioration of the workings during the shutdown, there was a marked improvement as compared with 1921 and 1920. The greatest factor in the gain was the improved condition and extent of the ore reserves. The reserves of smelting ore show an increase of 2,000 tons, and those of concentrating ore an increase of 145,000 tons. In addition, the reserves of concentrating ore show an increase in grade of 8 pounds to the ton of ore.

*Ore produced by Old Dominion Co., 1922.*

| | Short tons. | Percentage of copper. |
|---|---|---|
| Smelting ore | 51,791 | 7.65 |
| Concentrating ore | 148,225 | 4.29 |
| Converting ore | 2,938 | 4.13 |
| | 202,954 | 5.14 |

*Metals produced by Old Dominion Co., 1917–1922.*

| Year. | Ore.[a] | Copper. | Gold. | Silver. | Average grade of ore in copper. | Dividends. |
|---|---|---|---|---|---|---|
| | *Short tons.* | *Pounds.* | *Ounces.* | *Ounces.* | *Per cent.* | |
| 1917 | 199,888 | 32,365,795 | 3,897 | 165,703 | 4.97 | $2,376,262 |
| 1918 | 230,451 | 33,378,158 | 5,071 | 184,982 | 4.52 | 1,188,284 |
| 1919 | 253,686 | 28,166,396 | 5,756 | 137,071 | 4.28 | ..... |
| 1920 | 249,111 | 22,854,452 | 3,484 | 181,010 | 4.79 | ..... |
| 1921 | 61,753 | 7,389,648 | 1,187 | 71,155 | 5.31 | ..... |
| 1922 | 202,954 | 18,573,289 | 3,317 | 122,095 | 5.14 | ..... |

[a] Includes custom ores.

The plant of the Miami Copper Co. was operated at an average of about 80 per cent of normal capacity during 1922. The tonnage treated and the copper produced were the highest in the history of the property, exceeding those of 1918, which had been the record year. The metallurgical results during the year were also the best in the history of the property, the copper extraction being 86.36 per cent. The company reports that the new plant for elevating tailings, consisting of a battery of six Wilfley sand pumps, operated successfully and with considerable economy during the year. Four quarterly dividends, aggregating $2 a share, were paid during the year.

*Copper produced by Miami Copper Co., 1917–1922.*

| Year. | Ore. | Copper content. | Mill extraction. | Refined copper. | Cost of copper per pound. | Dividends. |
|---|---|---|---|---|---|---|
| | *Short tons.* | *Per cent.* | *Per cent.* | *Pounds.* | *Cents.* | |
| 1917 | 1,640,206 | 2.03 | 69.25 | 43,863,669 | 12.51 | $6,537,247 |
| 1918 | 2,132,941 | 2.026 | 71.15 | 58,407,563 | 14.833 | 3,362,013 |
| 1919 | 1,698,446 | 2.04 | 82.38 | 54,221,638 | 15.812 | 1,867,785 |
| 1920 | 1,801,958 | 1.968 | 82.48 | 55,581,328 | 11.898 | 1,494,228 |
| 1921 | 1,868,757 | 1.758 | 85.37 | 53,311,941 | 11.284 | 1,494,228 |
| 1922 | 2,183,020 | 1.883 | 86.36 | 67,454,447 | 9.730 | 1,494,228 |

*Milling operations of Miami Copper Co., 1922.*

| | | |
|---|---|---|
| Ore milled | short tons | 2,183,020 |
| Copper in ore | per cent | 1.883 |
| Concentrates produced | short tons | 81,425 |
| Copper in concentrates | per cent | 43.601 |
| | pounds | 71,004,668 |
| Copper recovered per ton of ore | do | 32.526 |
| Mill extraction | per cent | 86.36 |

*Cost of copper in concentrates f. o. b. cars at Miami, Ariz., 1922.*

| | Per ton of ore. | Per pound of copper. |
|---|---|---|
| Mining | $1.11304 | $0.035993 |
| Milling | .64117 | .020847 |
| General | .29975 | .009704 |
| | 2.05696 | 0.066544 |

*Ore reserves of Miami Copper Co. January 1, 1923.*

| | Short tons. | Percentage of copper. |
|---|---|---|
| High-grade sulphide ore | 6,756,187 | 2.26 |
| Mixed sulphide and oxide ore | 6,000,000 | 2.09 |
| Low-grade sulphide ore | 36,000,000 | 1.06 |
| | 48,756,187 | |

The Inspiration Consolidated Copper Co. resumed operations on a reduced scale February 15, 1922, and production was gradually increased throughout the year. The ore mined in 1922 contained 1.25 per cent of copper. The company believes that by 1924 the higher-grade ore of the Live Oak ore body will increase the average grade of sulphide ores considerably. The sales of metals during the year were considerably higher than production, with the result that stocks were materially reduced. The ore mined amounted to 14.5 tons per man-shift for all labor chargeable to the mining division, as compared with 19.1 tons in 1921. The decrease per man-shift was due to the building up and training of a practically new underground crew. The cost of fine copper produced during the period of operation, including depreciation but excluding depletion, Federal taxes, and shutdown expenses, amounted to 12.14 cents a pound, compared with 15.208 cents in 1921.

*Mill statistics, Inspiration Consolidated Copper Co., 1922.*

| | | |
|---|---|---|
| Total ore milled | dry tons | 3,667,495 |
| Ore milled per day | do | 11,437 |
| Average number of sections running | | 12 |
| Average rate per section | tons | 954 |
| Screen analysis of feed (on 48 mesh) | per cent | 4.2 |
| Assay mill feed | per cent of copper | 1.228 |
| Copper in feed, oxidized | per cent | 0.210 |
| Copper assay of general tailings | do | .272 |
| Copper in general tailings, oxidized | do | .187 |
| Copper in general concentrates, smelter assay | do | 26.213 |
| Copper in flotation concentrates | do | 31.43 |
| Copper in table concentrates | do | 9.05 |
| Moisture in general concentrates | do | 15.37 |
| Ratio of concentration | | 27.5 |
| Recovery of copper (calculated from smelter assays): | | |
| Assays only | per cent | 78.67 |
| Assays and weights of concentrates and ore | do | 77.71 |
| Assays and weights of concentrates and tailings | do | 78.49 |
| Recovery of copper sulphides | do | 91.96 |
| Water used per ton of ore | tons | 2.095 |

| | | |
|---|---|---|
| Power used per ton of ore milled: | | |
| Coarse crushing | kilowatt-hours | 0.53 |
| Fine grinding and concentrating | do | 10.44 |
| Blowers for flotation air | do | 2.34 |
| Filtering and reclaiming water | do | 0.76 |
| Lighting | do | 0.12 |
| | | 14.19 |
| Steel balls consumed per ton of ore milled | pounds | 1.75 |
| Flotation oil consumed per ton of ore milled: | | |
| Coal tar | do | 0.968 |
| Other oils | do | .108 |
| | | 1.076 |

*Copper produced by the Inspiration Copper Co., 1922.*

| | Ore treated (tons). | Copper produced (pounds). |
|---|---|---|
| Concentrating ore | 3,667,847.8 | 67,625,067 |
| Inspiration ore to smelter | 12,718.0 | 251,780 |
| Cordova ore to smelter | 10,513.0 | 219,060 |
| Warrior ore to smelter | 9,518.1 | 1,129,889 |
| Live Oak ore to smelter | 10,673.8 | 540,433 |
| Live Oak ore to leaching plant | 5,877 6 | 67,886 |
| | 3,717,148.3 | 69,834,115 |

The production of the Iron Cap Copper Co. averaged from 75 to 80 per cent of concentrator capacity in 1922.

*Metallic production of the Iron Cap Copper Co., 1919–1922.*

| | 1919 | 1920 | 1921 | 1922 |
|---|---|---|---|---|
| Ore (dry weight) short tons | 64,540 | 91,326 | 4,424 | 69,675 |
| Silver recovered and sold ounces | 104,458 | 113,323 | 4,002 | 72,005 |
| Copper recovered pounds | 7,156,270 | 8,235,670 | 385,548 | 5,829,122 |
| Average price received: | | | | |
| Per ounce silver | $1.104 | $1.083 | $1.015 | $0.9952 |
| Per pound copper | .18918 | .17444 | .12580 | .13425 |

*Result of mill operation of the Iron Cap Copper Co., 1922.*

| | | |
|---|---|---|
| Ore milled (dry) | short tons | 69,675 |
| Average assay of feed | per cent of copper | 4.65 |
| | ounces of silver per ton | 1.26 |
| Copper contained in ore | pounds | 6,474,973 |
| Silver contained in ore | ounces | 87,546 |
| Concentrates produced (dry) | short tons | 10,691 |
| Average assay of concentrates | per cent of copper | 28.69 |
| | ounces of silver per ton | 7.47 |
| Copper contained in concentrates | pounds | 6,135,916 |
| Silver contained in concentrates | ounces | 79,908 |
| Tailings rejected (dry) | short tons | 58,983 |
| Average assay of tailings | per cent of copper | .287 |
| | ounces of silver per ton | .129 |
| Copper contained in tailings | pounds | 339,057 |
| Silver contained in tailings | ounces | 7,638 |
| Recovery of copper | per cent | 94.76 |
| Recovery of silver | do | 91.27 |
| Operating cost per dry short ton | | $1.885 |

Copper production was resumed in the Copper Hill mine of the Arizona Commercial Mining Co. in March, but no work was done during 1922 in the Eureka mine. The company sold 8,999,447 pounds of refined copper in 1922, at an average price of 13.266 cents a pound.

*Copper produced by the Arizona Commercial Mining Co., 1919–1922.*

| Year. | Refined copper. | Gold. | Silver. |
|---|---|---|---|
| | *Pounds.* | *Ounces.* | *Ounces.* |
| 1919 | 7,280,861 | 1,310 | 16,918 |
| 1920 | 7,913,836 | 1,722 | 31,028 |
| 1921 | 572,616 | 163 | 3,001 |
| 1922 | 6,220,923 | 1,585 | 27,532 |

During the fiscal year October 1, 1921, to September 30, 1922, the Superior & Boston Copper Co. shipped 13,046 dry tons of ore, averaging 4.19 per cent of copper and 9.55 ounces of silver to the ton and containing in all 1,092,979 pounds of copper and 124,634 ounces of silver. During the same period 4,074 feet of development work was done.

*Morenci-Metcalf district.*—Inclusive of 1922 the Morenci-Metcalf district has produced a total of 1,528,272,000 pounds, or 4.92 per cent of the total output of the country since 1845. In total production it ranks sixth among the copper districts of the country, and for 1922 it ranked fifteenth.

*Copper produced in Morenci-Metcalf district, 1916–1922.*

| Year. | Pounds. | Average yield of copper from ore (per cent). | Year. | Pounds. | Average yield of copper from ore (per cent). |
|---|---|---|---|---|---|
| 1916 | 75,977,000 | 1.89 | 1920 | 35,746,000 | 1.73 |
| 1917 | 53,000,000 | 1.85 | 1921 | 11,420,000 | 1.47 |
| 1918 | 71,867,000 | 1.71 | 1922 | 14,175,000 | 2.76 |
| 1919 | 44,868,000 | 1.72 | | | |

The production of the Morenci branch of the Phelps Dodge Corporation, which includes properties formerly owned by the Arizona Copper Co., is given below. All concentrates in stock at the smelter on January 1, 1922, as well as all resulting from current production, were shipped during the year to the Douglas reduction works, as the Clifton smelter was idle during the entire year.

*Copper produced by Morenci branch of Phelps Dodge Corporation, 1922.*

| | Tons (dry weight). | Copper in ore. | |
|---|---|---|---|
| | | Per cent. | Pounds. |
| Concentrating ores: | | | |
| Coronado division | 108,172 | 2.03 | 4,399,595 |
| Morenci division | 84,518 | 2.60 | 4,402,597 |
| Morenci stock piles | 64,881 | 1.97 | 2,563,330 |
| | 257,571 | 2.20 | 11,365,522 |
| Lease ores | 2,580 | 12.90 | 665,702 |
| | 260,151 | 2.31 | 12,031,224 |

The Morenci branch was idle in 1920 and 1921. In 1918 it produced 480,407 short tons of ore containing 2.32 per cent of copper, from which 17,130,209 pounds of copper was obtained, and in 1919 it produced 253,208 tons of ore containing 2.25 per cent of copper, from which 11,414,031 pounds of copper was obtained.

The production of the Arizona Copper Co. from 1916 until it was taken over by the Phelps Dodge Corporation is shown below:

*Copper produced by Arizona Copper Co., 1916–1921.*

| Year ending Sept. 30— | Ore treated. | Copper produced. | Average yield. |
|---|---|---|---|
| | *Short tons.* | *Pounds.* | *Per cent.* |
| 1916 | 905,486 | 34,100,000 | 1.803 |
| 1917 | 1,178,087 | 42,482,000 | 1.830 |
| 1918 | 1,095,568 | 40,442,000 | 1.754 |
| 1919 | 1,147,659 | 36,474,000 | 1.611 |
| 1920 | 1,046,331 | 35,692,000 | 1.642 |
| 1921 [a] | 573,397 | 18,550,000 | 1.701 |

[a] Figures are for 8 months ending May 31, 1921, when plant was shut down.

*Jerome district.*—Inclusive of 1922 the Jerome district has produced a total of 1,415,899,000 pounds of copper, or 4.56 per cent of the total for the country since 1845. In total output it ranks seventh among the copper districts of the country, and in production for 1922 it ranks sixth. The principal producers of the district are the United Verde Copper Co. and the United Verde Extension Mining Co.

*Copper produced in the Jerome district, Ariz., 1916–1922, in pounds.*

| | | | |
|---|---|---|---|
| 1916 | 102,000,000 | 1920 | 107,084,000 |
| 1917 | 145,900,000 | 1921 | 26,568,000 |
| 1918 | 133,781,000 | 1922 | 74,794,000 |
| 1919 | 72,333,000 | | |

The United Verde Extension Mining Co. operated for 10 months during 1922, smelting 136,980 tons of ore. The copper on hand at the end of the year amounted to 11,569,156 pounds. The amount of ore developed above the 1,600-foot level is estimated at 1,036,166 tons averaging 9.7 per cent of copper and 0.03 ounce of gold and 2 ounces of silver to the ton. The company purchased some 80 acres of wholly undeveloped ground formerly owned by the Hull Copper Co. and lying west of its original holdings. The cost of producing copper, exclusive of depreciation, reserve to return capital (depletion), and taxes, was 6.93 cents a pound, as shown below, compared with 13.46 cents in 1921.

*Cost of producing copper by United Verde Extension Mining Co. in 1922.*

| | | |
|---|---|---|
| Mining | cents per pound | 2.32 |
| Smelting | do | 2.26 |
| Freight on ore | do | .07 |
| Freight on bullion, refining, selling | do | 2.11 |
| Other expenses | do | .17 |
| | | 6.93 |

*Copper produced by the United Verde Extension Mining Co., 1918–1922.*

| Year. | Ore treated. | Copper produced. | Silver. | Gold. |
|---|---|---|---|---|
| | *Short tons.* | *Pounds.* | *Ounces.* | *Ounces.* |
| 1918 | 133,535 | 55,491,077 | 503,739 | 3,046 |
| 1919 | 93,325 | 28,860,615 | 272,855 | 3,169 |
| 1920 | 161,617 | 41,942,700 | 359,370 | 5,530 |
| 1921 | 53,643 | 12,498,005 | 112,864 | 2,328 |
| 1922 | 136,980 | 31,640,714 | 238,764 | 5,788 |

*Ray or Mineral Creek district.*—To the end of 1922 the Ray or Mineral Creek district has produced 613,407,000 pounds of copper, or 1.98 per cent of the total output of the country since 1845. In total output it ranks tenth among the copper-producing districts of the country, and in production for 1922 it ranks ninth.

Operations were resumed by the Ray Consolidated Copper Co. early in April, 1922. The main effort of the company during the nine months of operation was to rebuild the organization as a whole, to put the entire mining and milling plant back into working condition, and to make such copper production as was possible. The company's president reports gratifying progress. No dividends were paid during the year, but total disbursements to stockholders from the beginning of operations have amounted to $25,412,620.67, and as these disbursements have resulted from the extraction and treatment of 25,106,650 tons of ore, they have been slightly in excess of $1 per ton of ore produced. The mining cost for the year was 99 cents a ton, compared with $1.31 a ton in 1921. These costs do not include depreciation nor the usual charge of 15 cents a ton to cover extinguishment of mine-development expense. The reserves calculated by deducting the ore mined during the year from the reserves reported at the end of the previous year amount to 81,463,085 tons.

*Copper produced by Ray Consolidated Mining Co., 1917–1922.*

| Year. | Ore milled. | Copper content. | Mill recovery. | Refined copper. | Cost per pound.[a] | Dividends and capital distributions. |
|---|---|---|---|---|---|---|
| | *Short tons.* | *Per cent.* | *Per cent.* | *Pounds.* | *Cents.* | |
| 1917 | 3,560,900 | 1.635 | 74.53 | 88,582,649 | 12.229 | $6,624,151 |
| 1918 | 3,411,000 | 1.613 | 74.92 | 83,599,160 | 17.695 | 5,125,831 |
| 1919 | 1,621,600 | 1.814 | 79.45 | 46,011,371 | 15.62 | 3,154,358 |
| 1920 | 1,706,928 | 1.720 | 81.98 | 47,062,030 | 16.144 | 1,577,179 |
| 1921 | 406,172 | 1.646 | 77.82 | 10,110,131 | 16.41 | ..... |
| 1922 | 1,178,350 | 1.587 | 76.66 | 27,953,408 | [b] 12.41 | ..... |

[a] Does not include amount received for gold and silver or miscellaneous income.
[b] Includes amount received for gold and silver and miscellaneous income but not charges for depreciation. Comparative value for 1921 was 16.25 cents.

*Ajo district.*—In 1922 the Ajo district produced a total of 26,613,000 pounds of copper, or 2.76 per cent of the total production of the country, thus standing tenth in rank among the copper-producing districts of the United States.

In August, 1922, production of ore at the mines of the New Cornelia Copper Co. was increased from 2,500 to 5,000 tons a day. For the first

seven months of the year the production was maintained at the rate of approximately 1,600,000 pounds of copper a month, and during the last four months it averaged slightly under 3,200,000 pounds a month. The costs for this period were the lowest in the history of the company. In 1922 the company sold 46,306,366 pounds of copper at an average price of 13.39 cents a pound. Four dividends amounting to $1,800,000 were paid during the year, bringing the dividends paid since the organization of the company to $3,150,000. The most important development during the year was the approval by the board of directors of an appropriation covering the construction of a 5,000-ton flotation mill for the treatment of sulphide ores. This action was taken because the carbonate ores on which the company has been operating will be exhausted within four or five years.

*Copper produced by the New Cornelia Copper Co. in 1920–1922, in pounds.*

| | 1920 | 1921 | 1922 |
|---|---|---|---|
| Electrolytic copper | 37,331,586 | 19,993,758 | 26,408,610 |
| Copper in cement copper shipped | 2,113,985 | 169,035 | 140,732 |
| Copper in ore shipped | 249,353 | 35,589 | 63,461 |
| Copper in concentrates shipped | 409,569 | | |
| | 40,104,493 | 20,198,382 | 26,612,803 |

## CALIFORNIA.

Inclusive of 1922 California has produced a total of 816,625,483 pounds of copper, which represents 2.63 per cent of the total for the United States since 1845. In 1922 California produced 20,440,430 pounds of copper, 2.15 per cent of the total for the country, compared with 15,906,883 pounds in 1921. In total output the State ranks sixth among the copper producers of the country, and in output for 1922 it ranked seventh. The copper has been derived chiefly from ores mined in the Shasta, Foothill, and Plumas districts, although numerous other districts have at various times, particularly in recent years, contributed some copper. At the present time the Plumas district is making practically the entire production for the State.

*Shasta district.*—The total production of the Shasta district, inclusive of 1922, was 575,652,000 pounds, or about 1.85 per cent of the total of the United States.

The mines of the Mountain Copper Co. (Ltd.) were closed during the year so far as copper production was concerned, but the directors have given instructions to reopen the mines and smelter. The consulting engineers of the company are of the opinion that the ore reserves are sufficient to yield 450 tons of copper a month for 18 months and that there is a good probability of developing additional ore of the same quality. Necessary repairs will occupy about 2 months, and the expected monthly output of 450 tons will not be attained for about 8 months.

*Foothill district.*—The total production in the Foothill district has been about 155,045,000 pounds of copper. None was produced in 1921 or 1922.

*Copper produced in Foothill district, Calif., 1916–1920.*

| Year. | Quantity. | Average yield. |
|---|---|---|
| | *Pounds.* | *Per cent.* |
| 1916 | 6,460,000 | 3.07 |
| 1917 | 8,000,000 | 4.18 |
| 1918 | 6,937,000 | 2.07 |
| 1919 | 2,048,000 | 1.69 |
| 1920 | 2,201,000 | .57 |

*Plumas district.*—The production of copper in the Plumas district in 1922 was 20,678,000 pounds, as compared with 11,583,000 pounds in 1921. This district ranked twelfth among the copper-producing districts of the country in 1922.

The Engels Copper Mining Co. is by far the largest producer in the district, with a production in 1922 of 14,075,947 pounds of copper, as compared with 11,500,993 pounds in 1921; 190,047.88 ounces of silver, compared with 168,699.18 ounces in 1921; and 2,074.324 ounces of gold, compared with 1,422.691 ounces in 1921. Compared with 1921, the operating cost showed a reduction of 2.48 cents per pound of copper, a total of $349,083.48 a year if applied to the production in 1922.

*Cost of producing copper by Engels Copper Mining Co., 1922.*

| | | Total. | Cost per pound of copper. |
|---|---|---|---|
| | | | *Cents.* |
| Ore on cars at Engels | | $1,058,267.25 | 7.52 |
| Freight and smelting charges | $718,569.39 | | |
| Credit value of gold and silver recovered | 228,604.76 | | |
| | | 489,964.63 | 3.48 |
| Operating and marketing cost | | 1,548,231.88 | 11.00 |
| Cost of depreciation and insurance, reserves and development | | 170,902.85 | 1.21 |
| Net cost | | 1,719,134.73 | 12.21 |

Experimental work carried on continuously throughout the year resulted in an increase of 2.7 per cent in mill extraction in 1922, the extraction in 1921 having been 84.48 per cent. This increase was achieved in spite of the fact that the mill treated an increased percentage of the disseminated bornite ore from the Engels mine, which has caused trouble in the mill heretofore.

*Operations at Superior mill, 1922.*

| | | |
|---|---|---|
| Ore milled | short tons | 362,959 |
| Average heads | per cent | 2.218 |
| Average tails | do | .272 |
| Actual extraction | do | 87.180 |
| Concentrates produced | pounds | 49,304,152 |
| Average content of concentrates | per cent | 28.55 |
| Copper produced | pounds | 14,075,946 |
| Silver produced | ounces | 190,048.1128 |
| Gold produced | do | 2,074.3257 |

*Ore reserves of Engels and Superior mines, December 31, 1922, in short tons.*[a]

| Mine. | Blocked ore. | | Probable ore. | Total. |
|---|---|---|---|---|
| | In place. | Broken in stopes. | | |
| Engels | 1,098,575 | 283,810 | 646,800 | 2,029,185 |
| Superior | 538,870 | 134,711 | 250,000 | 923,581 |
| | 1,637,445 | 418,521 | 896,800 | 2,952,766 |

[a] Estimate includes ore in pillars.

The company's report states that the above estimate of ore reserves is based on a technical interpretation of the conditions as found in the mines December 31, 1922, and must not be construed to include all ore, both probable and possible, that is contained in the mines. The company believes that the mines contain many times the tonnage given.

COLORADO.

In 1922 Colorado ores and concentrates yielded 3,635,916 pounds of blister copper, a decrease from 6,592,598 pounds in 1921. The production in 1922 brings the total for the State since 1845 to 294,241,102 pounds and gives it tenth rank for the year and in total production among the copper-producing States of the country. The production in 1922 was 0.38 per cent of the total for the country, and the total since 1845 was 0.95 per cent of the country's total. Colorado has no important district, now producing, in which copper is the principal valuable metal. The copper has been derived mainly from the treatment of mixed ores in which copper was a minor constituent, including lead-silver ores and pyritic ores rich in gold and silver. Much of the output is recovered as matte in lead furnaces.

IDAHO.

Inclusive of 1922 Idaho has made a total smelter production of 117,955,559 pounds of copper, which represents 0.38 per cent of the total for the country. In 1922 the State produced 3,504,944 pounds of copper, or 0.37 per cent of the total for the country. The State ranks eleventh in total output and in output for 1922. Since 1900 there has been intermittent production from the Alder Creek or MacKay district, which in 1922 produced 1,846,000 pounds.

MICHIGAN.

Michigan is one of the three large copper-producing States, ranking third in total output since 1845 and in output for 1922. Since 1845 it has produced 7,083,923,230 pounds of copper, or nearly 23 per cent of the total for the country. In 1922 Michigan produced 122,545,126 pounds of copper, compared with 100,918,001 pounds in 1921. That Michigan is losing ground as a copper-producing State is shown by the fact that in 1922 it produced only about 13 per cent of the total for the country, compared with 23 per cent of the total production since 1845. The Calumet & Hecla Mining Co. produced the largest

quantity of copper in 1922, followed in order by the Champion Copper Co. (a subsidiary of the Copper Range Co.), the Quincy Mining Co., the Ahmeek Mining Co. (a subsidiary of the Calumet & Hecla), and the Mohawk Mining Co.

*Copper ore produced in Lake Superior district, Mich., 1916–1922.*

| Year. | Short tons. | Yield of copper (per cent). | Year. | Short tons. | Yield of copper (per cent). |
|---|---|---|---|---|---|
| 1916 | 12,364,114 | 1.08 | 1920 | 5,938,967 | 1.30 |
| 1917 | 12,400,723 | .99 | 1921 | 3,610,648 | 1.20 |
| 1918 | 11,321,365 | .96 | 1922 | 4,952,264 | 1.23 |
| 1919 | 7,690,253 | 1.16 | | | |

*Ore milled and copper derived therefrom by Michigan companies in 1919–1922.*

[Compiled from the annual reports of the producing companies.]

| Company. | 1919 | | 1920 | | 1921 | | | 1922 | | |
|---|---|---|---|---|---|---|---|---|---|---|
| | Ore (short tons). | Copper (pounds per ton). | Ore (short tons). | Copper (pounds per ton). | Ore (short tons). | Copper (pounds). Per ton. | Copper (pounds). Total. | Ore (short tons). | Copper (pounds). Per ton. | Copper (pounds). Total. |
| Ahmeek | 756,870 | 22.80 | 822,192 | 24.9 | 212,170 | 29.48 | 6,255,200 | 439,769 | 33.85 | 14,885,081 |
| Allouez | 235,312 | 15.94 | 131,643 | 18.98 | | | | | | |
| Baltic | 235,832 | 33.35 | 175,357 | 37.71 | 195,816 | 34.15 | 7,608,847 | 165,804 | 32.14 | 5,329,568 |
| Calumet & Hecla | 1,830,760 | 23.91 | 1,560,240 | 27.87 | 261,320 | 37.75 | [a]9,865,400 | 618,800 | 47.08 | [a]29,130,500 |
| Centennial | 87,688 | 15.57 | 41,418 | 13.55 | | | | | | |
| Champion | 503,030 | 39.053 | 321,664 | 42.419 | 531,780 | 39.018 | 20,719,307 | 503,593 | 38.964 | 19,583,806 |
| Franklin | 109,565 | | | | | | | | | |
| Isle Royale | 724,667 | 17.95 | 591,971 | 17.94 | 116,576 | 21.37 | 2,491,000 | 246,641 | 26.92 | 6,639,970 |
| La Salle | 32,995 | 10.326 | 3,430 | 17.41 | | | | | | |
| Mass | 123,780 | 15.86 | | | | | | | | |
| Michigan | 62,373 | 27.21 | 46,289 | 23.23 | | | | | | |
| Mohawk | 560,734 | 22.93 | 434,988 | 23.61 | 688,273 | 20.42 | 14,054,235 | 512,393 | 21.88 | 11,209,396 |
| Osceola | 739,364 | 14.60 | 455,982 | 16.37 | | | | | | |
| Quincy | 960,393 | 20.28 | 809,263 | 23.75 | 767,100 | 22.12 | 16,960,265 | 674,499 | 22.83 | 15,402,726 |
| Seneca | | | | | 14,398 | 32.388 | 466,323 | 8,618 | 31.583 | 272,182 |
| Superior | 27,267 | 20.68 | 9,549 | 33.81 | | | | | | |
| Trimountain | 171,995 | 30.66 | 116,768 | 30.24 | 143,172 | 30.32 | 4,341,584 | 130,913 | 31.44 | 4,116,100 |
| Victoria | 89,206 | 14.00 | 61,031 | 16.50 | 20,400 | | | | | |
| White Pine | 84,008 | 23.56 | 93,260 | 19.85 | | | | | | |
| Winona | 39,654 | 14.153 | | | | | | | | |
| Wolverine [b] | 298,089 | 15.306 | 257,294 | 15.282 | 263,053 | 13.838 | 3,640,303 | 290,419 | 13.512 | 3,924,270 |

[a] Calumet & Hecla also produced 5,301,736 pounds of copper from the re-treatment of old mill tailings in 1921 and 11,362,500 pounds in 1922.
[b] Figures cover fiscal year ending June 30.

By April 1, 1922, the Calumet & Hecla, Ahmeek, and Isle Royale mining companies decided that conditions in the copper industry warranted the resumption of operations at a reduced rate. At the Ahmeek mine a new method of stoping on the Mass fissure is proving satisfactory, and nearly 1,400,000 pounds of copper was derived from this source in 1922. The Allouez, Centennial, La Salle, Osceola, Superior, and White Pine companies remained idle during the entire year. On September 15 all wages were increased somewhat over 10 per cent. At the idle mines this increase was paid to caretakers, watchmen, and pumpmen.

The Copper Range Co. had unsold copper on hand at the beginning of 1922 approximating more than three months' production. This has all been disposed of, and on April 17, 1923, for the first time since 1918, the production of the mines was sold ahead. Copper was produced by this company at an average cost of 13.22 cents a pound, exclusive of a charge of 3.91 cents a pound for depletion and depreciation. The Trimountain mine suspended production in December because of adverse operating conditions. Owing to the cutting off of production at the Trimountain mine and the restricted rate of production elsewhere, the Baltic mill was closed, leaving the Champion mill to do all stamping. The Copper Range Co. paid dividends of $394,422 in 1922, and the Champion Copper Co. paid dividends of $600,000.

Owing to a shortage of rock at both the Mohawk and Wolverine mills the mill of the Wolverine Copper Co. was closed September 11, and the rock of both companies was subsequently treated in the Mohawk mill. Copper was produced by the Mohawk Mining Co. in 1922 at an average cost of 11.673 cents a pound, exclusive of a charge of 4.39 cents a pound for depletion and depreciation. Sales of copper amounted to 15,688,599 pounds, at an average price of 13.556 cents a pound. Three dividends were paid during the year aggregating $300,000.

The Quincy Mining Co. operated at a loss during 1922, owing to the increased cost of producing copper in the last half of the year, which was caused by the shortage of underground labor, the caving of No. 6 shaft, and the higher price of coal due to the coal strike. During the first half of the year operations were carried on at a slight profit. The company received an average of a little more than 14 cents a pound for its copper. In addition 150,139 fine ounces of silver was recovered and sold to the Government. The development work throughout the mine aggregated about 2½ miles during the year.

The development operations of the Seneca Copper Corporation in 1922 are considered by the company to have added materially to the area of copper rock available for stoping.

## MONTANA.

Including the year 1922 Montana has made a total production of 8,226,735,885 pounds of copper, or over 26 per cent of the production of the United States since 1845, and thus ranks second among the copper-producing States in total production. In production for 1922 Montana again took second place, with a production of 165,341,414 pounds, compared with 49,471,206 pounds in 1921, when it dropped from second to fourth place. Montana's production comes almost entirely from the Butte district.

*Butte district.*—The Butte district has produced more copper than any other district in the United States, its total output through 1922 being 8,180,382,000 pounds of copper out of a total of 31,057,941,517 pounds for the country since 1845. The Anaconda Copper Mining Co. has been the largest contributing factor to this production.

*Copper and associated metals produced in Butte district, Mont., 1917–1922.*

| Year. | Copper. | Average yield in copper. | Gold. | Silver. |
|---|---|---|---|---|
| | *Pounds.* | *Per cent.* | *Ounce per ton.* | *Ounces per ton.* |
| 1917 | 270,500,000 | 2.81 | 0.0056 | 1.84 |
| 1918 | 321,104,000 | 2.17 | .0059 | 2.03 |
| 1919 | 169,051,000 | 2.16 | .0071 | 2.69 |
| 1920 | 176,399,000 | 1.76 | .0062 | 2.11 |
| 1921 | 47,958,000 | 2.10 | .0119 | 4.37 |
| 1922 | 165,374,000 | 2.06 | .0065 | 2.59 |

*Copper, gold, and silver produced by Anaconda Copper Mining Co. from company ores 1917–1922.*

| Year. | Ore treated. | Copper. | Silver. | Gold. | Dividends. |
|---|---|---|---|---|---|
| | *Short tons.* | *Pounds.* | *Ounces.* | *Ounces.* | |
| 1917 | 3,906,901 | 239,014,880 | 8,368,180 | 58,545 | $19,815,625 |
| 1918 | 4,350,446 | 272,923,031 | 10,076,748 | 64,318 | ..... |
| 1919 | 1,794,358 | 129,781,031 | 6,744,262 | 42,526 | 9,325,000 |
| 1920 | 1,828,380 | 138,763,065 | 6,420,026 | 32,530 | 6,993,750 |
| 1921 | 395,239 | 32,267,345 | 2,137,062 | 8,619 | ..... |
| 1922 | 1,878,162 | 141,741,235 | 6,755,212 | 25,720 | ..... |

The annual report of the Anaconda Co. for 1922 states that

Operations at Butte were resumed on January 16, gradually increasing during the year as the number of returning miners increased. There were mined 1,983,106.07 tons of ore, and 7,571.95 tons of precipitates were produced. At the concentrator there were treated 2,044,506.22 tons of ore, 81,154.90 tons of slimes from the ponds, 822,515.36 tons of copper tailings, and 91,920.83 tons of zinc-silver tailings. The leaching plant remained closed throughout the year. The Anaconda reduction works treated for all companies 2,224,709.46 tons of ore. Of the total amount, 1,878,162.56 tons of ore were produced by the mines of the company, 322,917.96 tons of ore were either purchased from or treated for other companies, and 23,628.94 tons of material were shipped from the old plants at Anaconda and Butte. No copper ores were treated at Great Falls, but a small tonnage of concentrates from Anaconda was used for the fluxing of zinc-plant residue. There were produced 157,346,016 pounds of fine copper, 7,367,859 ounces silver, and 26,026.110 ounces gold. Of this production, 141,741,235 pounds fine copper, 6,755,212.19 ounces of silver, and 25,719.945 ounces gold were produced for your company. The refinery at Great Falls produced during the year 140,901,359 pounds of cathodes, of which 133,868,138 pounds were melted into shapes at that point. The Raritan Copper Works, at Perth Amboy, N. J., refined for all companies 300,284,594 pounds fine copper, 8,086,857.98 ounces silver, and 33,873.532 ounces gold.

During the year the purchase of a majority of the issued shares of the Chile Copper Co. by the Anaconda Copper Mining Co. was completed. This purchase assures a supply of raw material for the manufacturing plants of the company for an indefinite period, as the Chile Copper mine is probably the largest copper mine in the world. The Anaconda Co. reports that the increase in its operations was due to the growth of the business of the American Brass Co., whose output of manufactured products increased from 213,486,566 pounds of metal in 1921 to 412,571,729 pounds in 1922, a gain of 93.3 per cent. In February, 1922, the Anaconda Copper Mining Co. acquired over 99 per cent of the stock of this company, and later it purchased the property of the Brown's Copper & Brass Rolling Mills (Ltd.), at New Toronto, Ontario, with the exception of the land and buildings, which it leased for a long period. A new corporation, the Anaconda American Brass (Ltd.), owned entirely by the American Brass Co., was formed to conduct this operation and to give better service to the Canadian trade.

The Butte & Superior Mining Co. continued the development of copper ore encountered in 1921, and although the developments have not yet reached a stage that would permit a technical calculation of definite ore reserves, the company states that as good an estimate as can be made closely approximates 200,000 tons of ore, averaging about 5 per cent of copper and 6.5 ounces of silver to the ton. The company believes that a much larger tonnage will be proved by further work.

The North Butte Mining Co. resumed copper mining June 1, 1922. Development work was carried on throughout the year, though at a slower rate than in 1921. The United Metals Selling Co. sold 16,717,191 pounds of copper at an average of 13.8843 cents a pound for the credit of the North Butte Mining Co.

*Copper, silver, and gold produced by North Butte Mining Co., 1917–1922.*

| Year. | Copper ore and precipitates treated. | Copper. | Silver. | Gold. | Dividends. |
|---|---|---|---|---|---|
| | *Short tons.* | *Pounds.* | *Ounces.* | *Ounces.* | |
| 1917 | 296,773 | 14,493,452 | 662,845 | 959 | $1,075,000 |
| 1918 | 453,356 | 20,680,695 | 891,157 | 1,375 | 430,000 |
| 1919 | 287,800 | 14,331,254 | 633,215 | 914 | ..... |
| 1920 | 315,233 | 16,666,819 | 693,633 | 1,004 | ..... |
| 1921 | 24,755 | 1,229,600 | 34,536 | 78 | ..... |
| 1922 | 172,749 | 9,504,389 | 308,681 | 568 | ..... |

The East Butte Copper Mining Co. suffered a loss of $134,343 in 1922 on mining operations, compared with a surplus in 1921 of $150,772.

*Operations of East Butte Copper Mining Co. for 1922.*

| | | |
|---|---|---|
| Ore mined (wet weight), Pittsmont | short tons | 100,827 |
| Average assay value, copper | per cent | 3.35 |
| Average assay value, silver | ounces | 2.57 |
| Cost of mining per ton, including development | | $7.07 |
| Company ore treated (dry weight) | short tons | 97,202 |
| Customs ore treated (dry weight) | do | 88,065 |
| Total ore treated | do | 185,267 |
| Copper produced, Pittsmont smelter | pounds | 12,347,178 |
| Silver produced, Pittsmont smelter | ounces | 542,650 |
| Gold produced, Pittsmont smelter | do | 875 |
| Gold produced, Swissmont property | do | 5,692 |
| Gross value of metals shipped | | $2,362,296.05 |
| Other income | | 36,548.88 |
| Gross income from operations | | 2,398,844.93 |
| Total cost of copper delivered New York | $2,506,794.30 | |
| Miscellaneous operations | 12,480.32 | |
| Total cost of operations | | 2,519,274.62 |
| Loss on mining operations | | 120,429.69 |
| Depreciation | | 1,133.96 |
| Outside exploration | | 12,779.56 |
| Deficit from all operations | | 134,343.21 |
| Copper produced | pounds | 12,347,178 |
| Price per pound received, New York | cents | 13.5167 |
| Cost of production per pound delivered, New York | do | 14.7306 |
| Loss per pound | do | 1.2139 |
| Average price per ounce received for silver, New York | do | 99.6314 |
| Price per ounce received for gold, New York | | $20.00 |

The company reports a reduction in the grade of ore produced from 4.88 per cent of copper in 1921 to 3.35 per cent in 1922, due in part to the shortage and inefficiency of labor, which influences the character of results in the sorting of ores. The difference was further influenced by the exhaustion of certain small bodies of high-grade ore near the oxidized zone worked in 1921. Development for the year places in sight a tonnage of ore somewhat in excess of that removed during the year.

The Davis Daly Copper Co. resumed operations about June 1, 1922, and production at the Colorado mine was steadily increased to an average of 800 to 900 tons of ore a day. Shipments during December were the largest in the history of the company. The Colorado mine produced 91,206 tons during the six months beginning in June, yielding 7,035,456 pounds of copper and 355,660 ounces of silver. During the year suit was brought by the Anaconda Copper Mining Co. against the Davis Daly Copper Co. and cross action was brought by Davis Daly against Anaconda to try the question of the apex rights on the veins heretofore operated by Davis Daly and of the right of Anaconda to operate within the vertical boundaries of certain territory owned by Davis Daly. Temporary injunctions have been granted to both companies.

The Tuolumne Copper Mining Co. did not do any mining in 1922, and its operations were confined to development and repair work.

## NEVADA.

Inclusive of 1922, Nevada has produced a total of 977,907,045 pounds of copper, or a little over 3 per cent of the total for the country since 1845, and thus ranks fifth among the copper-producing States. In 1922 Nevada ranked eighth and produced 20,398,611 pounds of copper, compared with 15,129,116 pounds in 1921 and 55,580,322 pounds in 1920.

*Ely district.*—The total production of the Ely district through 1922 has been 849,281,000 pounds of copper, representing 2.73 per cent of the total for the country since 1845. In 1922 it produced 22,615,000 pounds of copper, or 2.34 per cent of the total. In total output it ranks eighth among the copper districts of the country, and in output for 1922 it ranked eleventh.

*Smelter production of metals in Ely (Robinson) district, Nev., 1916–1922.*

| Year. | Ore. | Copper produced. | Average yield in copper. | Gold and silver, per ton of ore. |
|---|---|---|---|---|
| | *Short tons.* | *Pounds.* | *Per cent.* | *Cents.* |
| 1916 | 4,053,526 | 93,037,587 | 1.14 | 20 |
| 1917 | 4,466,017 | 93,615,355 | 1.05 | 18 |
| 1918 | 4,519,445 | 92,396,638 | 1.02 | 24 |
| 1919 | 2,273,961 | [a] 47,871,048 | 1.05 | 17 |
| 1920 | 2,589,546 | [a] 48,347,828 | .93 | 21 |
| 1921 | 490,810 | [a] 10,282,527 | 1.28 | 25 |
| 1922 | 630,871 | [a] 22,614,736 | 1.79 | 19 |

[a] Mine production.

Production was resumed by the Nevada Consolidated Copper Co. early in April. It is reported that good progress was being made toward a return to capacity output when the concentrating plant was almost totally destroyed by fire on July 9. This mishap restricted operation to production from concentrates on hand and small quantities of direct smelting ore. A portion of one section of the mill, having a capacity to treat approximately 1,000 tons of ore daily, was placed in continuous operation on September 16. The company reports that contact ore from the Ruth ore body to the amount of 489,718 tons, averaging 7 per cent of copper, has been carried into ore reserves and that there is every indication that additional tonnage of this class of ore will be proved by further development. The cost of production excluding depreciation charges, for which there was no cash outlay, but including tax accruals (except Federal) and all fixed and general administrative expenses chargeable to operations, after crediting the value of gold and silver recovered and miscellaneous earnings, was 9.62 cents per net pound of refined copper.

*Metals produced by Nevada Consolidated Copper Co., 1917–1922.*

| Year. | Ore treated. | Average assay of copper. | Average extraction of copper. | Refined copper produced. | Dividends. |
|---|---|---|---|---|---|
| | *Short tons.* | *Per cent.* | *Per cent.* | *Pounds.* | |
| 1917 | 4,064,095 | 1.462 | 73.08 | 82,040,508 | $8,297,746 |
| 1918 | 3,999,526 | 1.506 | 69.95 | 76,607,062 | 6,498,235 |
| 1919 | 2,135,425 | 1.599 | 70.49 | 43,971,892 | 2,999,186 |
| 1920 | 2,568,588 | 1.449 | 70.20 | 48,311,985 | 1,499,593 |
| 1921 | 392,645 | 1.49 | 75.23 | 9,362,325 | ..... |
| 1922 | 518,523 | 1.60 | ..... | 23,762,675 | ..... |

*Ore reserves of the Nevada Consolidated Copper Co., December 31, 1922.*

| | Pits. | | Ruth ore body. | | | | Total. | |
|---|---|---|---|---|---|---|---|---|
| | | | Porphyry. | | Sedimentary rock. | | | |
| | Tons. | Per cent. | Tons. | Per cent. | Tons. | Per cent. | Tons. | Per cent. |
| Ore remaining Dec. 31, 1921 | 52,347,981 | 1.42 | 11,053,228 | 2.334 | ..... | ..... | 63,401,209 | 1.58 |
| Ore developed in 1922 | ..... | ..... | ..... | ..... | 489,718 | 6.898 | 489,718 | 6.898 |
| | 52,347,981 | 1.42 | 11,053,228 | 2.334 | 489,718 | 6.898 | 63,890,927 | 1.621 |
| Mined in 1922 | 349,320 | 1.45 | 162,064 | 1.892 | 119,452 | 5.620 | 630,836 | 2.403 |
| Ore remaining Dec. 31, 1922 | 51,998,661 | 1.42 | 10,891,164 | 2.341 | 370,266 | 7.310 | 63,260,091 | 1.613 |

The Consolidated Coppermines Corporation is a reorganization of the old Consolidated Coppermines Co., the Giroux, and others in the Kimberly part of the Ely district, and is practically a new company, with Howard D. Smith, of San Francisco, as president, John D. Sloane as secretary-treasurer, and Col. Robert Marsh as general manager. Development and exploration work has been pushed, and churn drilling in the Richards area has disclosed the presence of

large bodies of high-grade ore, which are being rapidly developed. The underground developments in the Richards area were visited by the writer in June, 1923, and appear very promising. The new management is energetic and capable, and the mines should soon be brought to the producing stage.

*Yerington district.*—In the Yerington district in 1922 neither production nor development operations were carried on by the Mason Valley Mines Co. The production of the district has fallen from 19,396,000 pounds in 1917 to nothing in 1921 and 1922.

*Copper produced in Yerington district, Nev., 1917–1920, in pounds.*

| | | | |
|---|---|---|---|
| 1916 | 3,491,000 | 1919 | 3,077,000 |
| 1917 | 19,396,000 | 1920 | 1,046,000 |
| 1918 | 17,139,000 | | |

## NEW MEXICO.

In 1922 New Mexico produced 29,127,329 pounds of copper, compared with 18,076,909 pounds in 1921. The total production since 1845 has been 745,330,724 pounds of copper, representing nearly 2½ per cent of the total production for the country. New Mexico ranks seventh among the copper-producing States. The principal producing districts are those of Grant and Hidalgo counties.

*Santa Rita district.*—From the best sources available it is estimated that the total production of copper through 1922 in the Santa Rita district has been 655,191,000 pounds. This gives the district ninth rank among the copper-producing districts in total production for the country. In 1922 the Santa Rita district produced 28,408,000 pounds and ranked eighth among the copper-producing districts.

*Copper produced in Santa Rita district, N. Mex., 1916–1922, in pounds.*

| | | | |
|---|---|---|---|
| 1916 | 74,228,000 | 1920 | 44,400,000 |
| 1917 | 82,200,000 | 1921 | 9,138,000 |
| 1918 | 77,547,000 | 1922 | 28,408,000 |
| 1919 | 40,359,000 | | |

The Chino Copper Co. resumed operations shortly after April 1, 1922, and the mill averaged about 45 per cent of its capacity. The steam shovels removed 1,809,200 cubic yards of ore and waste, of which 961,286 cubic yards was stripping, the remainder being equivalent to 1,659,781 tons of ore. From the beginning of steam-shovel operations, September 23, 1910, there has been removed 44,029,010 cubic yards of material, of which 30,986,460 cubic yards was waste, the remainder being equivalent to 25,528,683 tons of ore. It is estimated that at the end of the year there remained unmined and fully developed ore amounting to 101,802,771 tons of an average grade of 1.526 per cent of copper, and in addition a mined reserve of 2,074,658 tons averaging 1.354 per cent of copper in the stock piles at Santa Rita, and 88,465 tons averaging 1.37 per cent of copper in a special reserve for experimental purposes. The total reserve unmined and untreated is therefore 103,965,894 tons of an average grade of 1.523 per cent of copper. For several years the Chino Copper Co. has been experimenting with a process designed

to improve recoveries from oxidized copper minerals. These experiments have progressed far enough to justify the erection of apparatus on a commercial scale. A 300-ton unit was completed in September, and increased extractions were made from the beginning and have nearly reached the results attained on a smaller scale. The company believes that this process can eventually be used profitably on all ores that are oxidized or partly oxidized, such as have been the cause of low or indifferent recoveries in the past, and arrangements are in progress for applying it to a larger tonnage. The Chino Copper Co. began producing late in 1911.

*Metals produced by Chino Copper Co., N. Mex., 1917–1922.*

| Year. | Ore milled (short tons). | Copper content (per cent). | Mill recovery (per cent). | Refined copper produced (pounds). | Gold, silver, and miscellaneous income (cents per pound). | Dividends. |
|---|---|---|---|---|---|---|
| 1917 | 3,608,100 | 1.64 | 69.32 | 79,636,235 | .159 | $8,612,802 |
| 1918 | 3,836,400 | 1.63 | 63.275 | 75,655,641 | .109 | [a] 3,914,910 |
| 1919 | 1,765,200 | 1.82 | 65.67 | 40,488,706 | .216 | [b] 2,609,940 |
| 1920 | 1,838,140 | 1.76 | 70.67 | 44,051,849 | .570 | [c] 978,728 |
| 1921 | 361,660 | 1.70 | 77.36 | 9,137,282 | .570 | ..... |
| 1922 | 1,416,869 | 1.55 | 66.99 | 28,406,314 | .90 | ..... |

[a] $1,087,475 represents distribution of capital.
[b] Total represents distribution of capital; no dividends paid during 1919.
[c] $652,485 represents distribution of capital.

*Burro Mountain district.*—The Burro Mountain district, southwest of Silver City, has produced about 68,669,000 pounds of copper since the beginning of operations. This district was idle in 1922.

The Burro Mountain branch of the Phelps Dodge Corporation was closed during the entire year 1922. Only sufficient men to run the Diesel engines and keep the mine unwatered and to serve as watchmen were retained.

*Lordsburg district.*—The Lordsburg district, in Hidalgo County, has been a steady producer of copper for many years.

*Copper produced in Lordsburg district, N. Mex., 1917–1922, in pounds.*

[Mine figures.]

| | | | |
|---|---|---|---|
| 1917 | 4,262,000 | 1920 | 2,696,000 |
| 1918 | 2,215,000 | 1921 | 579,000 |
| 1919 | 3,516,000 | 1922 | 3,217,000 |

## TENNESSEE.

In 1922 Tennessee produced 14,226,232 pounds of copper, as compared with 15,084,294 pounds in 1921. The total smelter production since 1845 is about 412,779,000 pounds, representing about 1⅓ per cent of the total for the country and giving Tennessee ninth rank among the copper-producing States. The entire output has come from the Ducktown district, in the extreme southeastern part of the State, in Polk County.

*Metals produced in Ducktown district, Tenn., 1917–1922.*

[Smelter figures.]

| Year. | Ore treated. | Copper produced. | Average yield of copper. | Gold and silver per ton of ore. |
|---|---|---|---|---|
| | *Short tons.* | *Pounds.* | *Per cent.* | *Cents.* |
| 1917 | 589,004 | 16,093,757 | 1.37 | 15 |
| 1918 | 529,012 | 15,053,568 | 1.42 | 18 |
| 1919 | 555,018 | 15,629,454 | 1.41 | 21 |
| 1920 | 589,853 | 16,727,803 | 1.42 | 21 |
| 1921 | 564,457 | 15,084,294 | 1.34 | 18 |
| 1922 | 557,750 | 14,226,232 | 1.28 | 15 |

In 1922 the Tennessee Copper & Chemical Corporation produced 7,553,281 pounds of copper, compared with 8,018,577 pounds in 1921. The company's report states that owing to the nature of its operations, the decrease in demand for sulphuric acid and the consequent curtailment of acid production by the company necessitated a decrease in copper production. The company produced 218,676 tons of 60° acid in 1922, compared with 242,743 tons in 1921 and 333,629 tons in 1920. During 1922 plans to permit a more flexible operation were put into effect through the construction of a flotation plant and the installation of a Peirce-Smith basic lined converter, which has sufficient capacity to treat the flotation concentrates. The blast furnaces will still be operated in conjunction with the production of sulphuric acid, but production from the flotation plant can be maintained without regard to the demand for acid. The company's net operating profit for the year was $707,047.13, compared with $526,347.97 in 1921.

The Burra Burra mine was operated throughout the year, and the London mine resumed mining operations November 1.

*Copper and sulphuric acid produced by Tennessee Copper & Chemical Corporation, 1917–1922.*

| Year. | Ore smelted. | Copper. | Sulphuric acid, 60° Baumé. | Cost of copper per pound. | Dividends. |
|---|---|---|---|---|---|
| | *Short tons.* | *Pounds.* | *Short tons.* | *Cents.* | |
| 1917 | 457,902 | 10,547,708 | 262,857 | 14.90 | ..... |
| 1918 | 402,071 | 9,819,838 | 283,092 | 18.526 | $392,817 |
| 1919 | 413,877 | 10,414,815 | 266,627 | 18.715 | ..... |
| 1920 | 404,060 | 10,358,237 | 333,629 | 19.135 | ..... |
| 1921 | 302,584 | 8,018,577 | 242,743 | 16.705 | ..... |
| 1922 | 287,499 | 7,553,281 | 218,676 | 13.337 | ..... |

The Ducktown Sulphur, Copper & Iron Co. operated its two 600-ton blast furnaces and 20-foot converter during the year. This company and the Tennessee Copper & Chemical Corporation are the only copper producers in Tennessee.

## UTAH.

The total smelter production of copper from Utah to the end of 1922 amounted to 2,488,228,524 pounds, representing 8 per cent of the total for the country since 1845 and giving Utah fourth rank among the

copper-producing States. In 1922 also Utah ranked fourth, producing 79,655,563 pounds of copper, compared with 45,831,959 pounds in 1921.

*Bingham district.*—The total production of the Bingham district through 1922 has been 2,156,853,000 pounds of copper, or 6.94 per cent of the total production for the country since 1845. The mine production for 1922 increased to 91,762,000 pounds from 28,011,000 pounds in 1921. The production for 1921, however, was the smallest in many years. The district ranks fourth in total production and fourth in production for 1922.

The Utah Copper Co. is by far the largest producer in the district and in the State. It resumed operations on a small scale early in April, 1922. The net income of the company for the period of active operation in 1922 was $4,478,677.07, and additional miscellaneous earnings make a total of $4,890,250.65. Charges for depreciation of plant and equipment (for which there was no cash outlay but which constituted a heavy charge); loss on property retired, replaced, or abandoned; expenses incurred during the first quarter for maintenance of properties when idle; and payment of deferred royalties involved in the settlement of litigation with Minerals Separation made the net increase in surplus account $1,687,999.81 for the year. Extensive betterments at the Magna concentrator, consisting of a railroad car tipple, a new primary crushing plant, alterations and additions to the secondary crushing plant, some modifications of existing concentration equipment, and the installation of an entirely new and complete flotation plant, have been authorized and are under way. The company states that after these improvements the mill will have a capacity of 24,000 tons of ore daily, which will bring the combined economic capacity of the Arthur and Magna plants to 40,000 tons a day. The company also states that development work during the year indicates additional commercial ore much in excess of the tonnage mined during the year. This ore will not be added to the reserves, however, until the area is fully developed. The ore reserves previously reported minus the ore mined during the year, 4,364,251 tons, amount to 358,545,849 tons, averaging approximately 1.35 per cent of copper. Up to December 31, 1922, there has been extracted from the entire property 96,061,851 tons of concentrating ore averaging 1.366 per cent of copper.

*Metals produced by Utah Copper Co. from ore milled, 1917–1922.*

| Year. | Ore milled. | Copper content. | Mill recovery. | Copper.[a] | Gold and silver per pound of copper. | Net cost per pound of copper.[b] | Dividends. |
|---|---|---|---|---|---|---|---|
| | *Short tons.* | *Per cent.* | *Per cent.* | *Pounds.* | *Cents.* | *Cents.* | |
| 1917 | 12,542,000 | 1.337 | 61.10 | 195,837,111 | 0.70 | 10.95 | [c] $23,555,105 |
| 1918 | 12,160,700 | 1.226 | 65.11 | 188,092,405 | .79 | 14.53 | [d] 16,244,900 |
| 1919 | 5,538,700 | 1.26 | 78.46 | 105,088,740 | .83 | 12.366 | [e] 9,746,940 |
| 1920 | 5,556,800 | 1.16 | 81.38 | 101,897,758 | .81 | 13.145 | [f] 9,746,940 |
| 1921 | 1,220,700 | 1.16 | 83.87 | 24,511,593 | [g] 1.15 | 11.57 | [h] 4,061,225 |
| 1922 | 4,364,251 | 1.26 | 80.00 | 84,777,712 | [g] 1.45 | 7.82 | [h] 3,248,980 |

[a] Net production, not copper content of concentrates.
[b] Value of precious metals and railway earnings deducted.
[c] Includes $2,842,857 capital distribution.
[d] Includes $3,655,102.50 capital distribution.
[e] Includes $7,797,552 capital distribution.
[f] Includes $7,403,997.35 capital distribution.
[g] Includes miscellaneous income. Comparative figure for 1920 is 2.09 cents.
[h] Total represents capital distribution.

*Cost of mining, milling, and concentrating copper ore by Utah Copper Co., 1917–1922.*

| Year. | Ore. | Cost per ton. | | | |
|---|---|---|---|---|---|
| | | Mining. | Transportation. | Milling. | Total. |
| | *Short tons.* | | | | |
| 1917 | 12,542,000 | $0.4446 | $0.2794 | $0.6930 | $1.4170 |
| 1918 | 12,160,700 | .5370 | .2983 | .9277 | 1.7630 |
| 1919 | 5,538,700 | .4900 | .3040 | 1.2062 | 2.0002 |
| 1920 | 5,556,800 | .4823 | .2591 | 1.2472 | 1.9886 |
| 1921 | 1,220,700 | .4998 | .1921 | 1.1679 | 1.8598 |
| 1922 | 4,364,251 | .3833 | .1612 | .8417 | 1.3862 |

The mine of the Utah Consolidated Mining Co. was closed during the first half of 1922, owing to the low price of copper and the large stocks of metal in the hands of the producers. Operations were resumed on a small scale, and owing to the shortage of mining labor could not be brought up to more than two-thirds capacity. The suit between the Utah Consolidated and Utah Apex companies was decided finally in favor of Utah Apex. The Utah Consolidated Mining Co. had been mining an ore body in its extension beneath the surface boundaries of the properties of the Utah Apex Co., on the principle that the owner of the apex or outcrop of the belt or stratum of limestone that runs through the Bingham district was entitled to follow it to the greatest depths and was entitled to the ownership of all ore bodies found therein. The court did not support this view and required the company to pay for the ore mined and deprived it of mining rights in places. The milling recoveries for the year, without considering the concentrate material used in bedding down the milling system at the start, were copper, 82.37 per cent; gold, 57.79 per cent; and silver, 55.39 per cent. By December the recoveries had increased to copper, 93.49 per cent; gold, 60.85 per cent; and silver, 57.77 per cent. The company reports 715,700 tons of ore in sight, averaging 1.89 per cent of copper and 0.046 ounce of gold and 0.468 ounce of silver to the ton.

*Copper, gold, and silver produced by Utah Consolidated Mining Co., 1917–1922.*

| Year. | Ore. | Copper content. | Copper.[a] | Gold per ton. | Silver per ton. | Dividends. |
|---|---|---|---|---|---|---|
| | *Short tons.* | *Per cent.* | *Pounds.* | *Ounce.* | *Ounces.* | |
| 1917 | 226,536 | 1.797 | 7,968,165 | 0.050 | 0.764 | $1,050,000 |
| 1918 | 221,651 | 2.03 | 8,476,197 | .054 | .82 | 450,000 |
| 1919 | 126,893 | 2.22 | 5,710,346 | .07 | 1.27 | ..... |
| 1920 | 57,747 | 2.457 | 3,187,492 | .0525 | 1.33 | ..... |
| 1921 | 1,183 | 2.07 | 41,073 | .026 | .69 | ..... |
| 1922 | 109,320 | 2.033 | 3,410,518 | .047 | .375 | ..... |
| | 5,130 | 2.16 | | .055 | .40 | ..... |

[a] Includes copper derived from lead ores.

The mine of the Montana-Bingham Consolidated Mining Co. was operated throughout the year. In order to avoid further assessments the company has limited development work in proportion to operating revenues, attempting no more than could be borne by the excess proceeds of ore sold over mining costs. The established policy of limiting development to the most favorable places, where minimum expenditures are most likely to produce maximum results, has been adhered to.

*Metals produced by the Montana-Bingham Consolidated Mining Co., 1919–1922.*

| Year. | Ore produced. | Metal contents. | | | | Smelter returns. |
|---|---|---|---|---|---|---|
| | | Gold. | Silver. | Copper. | Lead. | |
| | *Short tons.* | *Ounces.* | *Ounces.* | *Pounds.* | *Pounds.* | |
| 1919 | 3,855.38 | 205.598 | 14,114 | 505,906 | 53,201 | $76,065.93 |
| 1920 | 4,660.55 | 348.606 | 12,663 | 750,210 | 16,278 | 79,382.77 |
| 1921 | 24,525.68 | 1,354.941 | 42,869 | 1,581,857 | 21,402 | 140,188.82 |
| 1922 | 20,936.76 | 1,027.311 | 33,014 | 1,088,711 | 44,932 | 105,422.76 |

The Bingham Mines Co. operated its Dalton and Lark group of mines during the year, with the results shown below:

*Copper, lead, gold, and silver produced by the Bingham Mines Co. from the Dalton and Lark mines in 1922.*

| | Ore. | | Copper. | Lead. | Gold. | Silver. |
|---|---|---|---|---|---|---|
| | *Wet tons.* | *Dry tons.* | *Pounds.* | *Pounds.* | *Ounces.* | *Ounces.* |
| Lead | 976.00 | 914.026 | 13,037 | 369,562 | 18.282 | 5,371.70 |
| Copper | 20,508.19 | 19,717.623 | 227,849 | ..... | 910.387 | 58,511.89 |
| | 21,484.19 | 20,631.649 | 240,886 | 369,562 | 928.669 | 63,883.59 |

*Tintic district.*—In the Tintic district the production of copper is largely incidental to the production of other metals. The quantity of local ore in which copper is the most valuable metal is very small. It is estimated that inclusive of 1922 the district has made a total production of 156,644,000 pounds of copper.

*Copper produced in Tintic district, Utah, 1916–1922, in pounds.*

[Mine figures.]

| | | | |
|---|---|---|---|
| 1916 | 7,107,000 | 1920 | 3,003,000 |
| 1917 | 9,118,000 | 1921 | 1,570,000 |
| 1918 | 6,569,000 | 1922 | 2,295,000 |
| 1919 | 3,251,000 | | |

*Beaver district.*—Inclusive of 1922 the Beaver district has yielded about 49,198,000 pounds of copper.

*Copper produced in Beaver County, Utah, 1916–1922, in pounds.*

[Mine figures.]

| | | | |
|---|---|---|---|
| 1916 | 3,204,000 | 1920 | 47,000 |
| 1917 | 3,702,000 | 1921 | 28,000 |
| 1918 | 2,636,000 | 1922 | 47,000 |
| 1919 | 539,000 | | |

## REFINERY PRODUCTION.

The refinery output of copper in the United States in 1922 was made by 11 plants, 9 of which employed the electrolytic method and 3 employed the furnace process on Lake Superior copper, the Calu-

met & Hecla plant employing both methods. Six of the large electrolytic refineries are on the Atlantic tidewater, and the three Lake refineries are on the Great Lakes; only two plants are located west of the Great Lakes—one at Great Falls, Mont., and one at Tacoma, Wash. In addition to these refineries there are numerous plants in different parts of the country that make a considerable output from old copper, brass, and other alloys of copper. The output of the regular refining plants is in the form of casting, Lake, and electrolytic copper.

### CASTING AND PIG COPPER.

Blister copper that is low in precious metals and sufficiently free from impurities for certain uses is refined by the furnace process and ordinarily cast into ingots. This copper is usually unfit for uses requiring a high-grade copper, such as electric transmission, brass manufacture, and rolling, but is suitable for copper castings, and a large part of it is put to that use. Lake copper excepted, a comparatively small percentage of the copper output carries so small a content of precious metals that, together with the added value of electrolytic copper, it will not more than pay for the electrolytic refining of the copper; consequently the output of casting copper is small. Some blister or pig copper low in precious metals has been exported without further treatment and is probably consumed without electrolytic refining. A large percentage of the pig and casting copper shown in the table is from Arizona. Some of the districts produced a rather high grade of blister copper carrying a small amount of precious metals, and it is found profitable to market some of this copper without electrolytic refining. During 1922 the production of furnace-refined new casting copper amounted to 15,180,723 pounds. No unrefined pig and best select copper was reported as produced in 1922.

### LAKE COPPER.

By Lake copper, as the term is used in this report, is meant the output of the Lake smelters. A considerable portion of this output is refined electrolytically, but most of the electrolytically refined Lake copper is mixed with furnace-refined copper or is sold as some brand of Lake copper. Of the 122,545,126 pounds of copper produced by the Lake smelters, 31,062,869 pounds was refined electrolytically, either to free the copper from impurities or to recover the silver content.

### ELECTROLYTIC COPPER.

Under electrolytic copper, in the table below, is included all new copper that was refined electrolytically, except that from the Lake district that was marketed as Lake copper. In 1922 the production of electrolytic copper from primary materials of domestic origin amounted to approximately 766,945,000 pounds, and from materials of foreign origin to 448,785,000 pounds, and in addition 100,792,000 pounds was produced from secondary sources—a total electrolytic production of 1,316,522,000 pounds for the year.

## REFINED COPPER.

The total output of new refined copper in 1922 was 1,359,000,000 pounds, an increase of 339,000,000 pounds from that of 1921.

*Primary and secondary copper produced by regular refining plants and imported in 1913 and 1918–1922, in pounds.*

| | 1913 | 1918 | 1919 | 1920 | 1921 | 1922 |
|---|---|---|---|---|---|---|
| Primary: | | | | | | |
| Domestic [a]— | | | | | | |
| Electrolytic | 1,022,497,601 | 1,560,327,422 | 1,233,994,324 | 1,010,240,867 | 506,532,984 | 766,944,836 |
| Lake | 155,715,286 | 231,096,158 | 177,594,135 | 153,483,952 | 100,918,001 | 122,545,126 |
| Casting | 22,606,040 | 15,284,635 | 18,223,145 | 13,905,114 | 1,740,393 | 15,180,723 |
| Pig and best select | 36,004,986 | 76,165,976 | 3,674,191 | 4,793,307 | 222,878 | ..... |
| | 1,236,823,913 | 1,882,874,191 | 1,433,485,795 | 1,182,423,240 | 609,414,256 | 904,670,685 |
| Foreign [a]— | | | | | | |
| Electrolytic | 378,243,869 | [b] 492,181,364 | [b] 370,558,779 | [b] 450,194,958 | [b] 405,337,490 | [b] 448,784,819 |
| Casting and best select | ..... | 57,329,735 | 1,262,227 | 2,290,446 | 5,275,350 | 5,203,597 |
| | 1,615,067,782 | 2,432,385,290 | 1,805,306,801 | 1,634,908,644 | 1,020,027,096 | 1,358,659,101 |
| Secondary: | | | | | | |
| Electrolytic | 14,862,577 | 34,674,062 | 32,408,548 | 32,856,549 | 82,017,382 | 100,792,685 |
| Casting | 22,360,182 | 9,018,049 | 38,876,481 | 49,130,510 | 24,467,951 | 45,217,857 |
| | 37,222,759 | 43,692,111 | 71,285,029 | 81,987,059 | 106,485,333 | 146,010,542 |
| Total output | 1,652,290,541 | 2,476,077,401 | 1,876,591,830 | 1,716,895,703 | 1,126,512,429 | 1,504,669,643 |

[a] The separation of refined copper into metal of domestic and foreign origin is only approximate, as an accurate separation at this stage of manufacture is not possible.
[b] Includes refined copper imported.

If the output of plants treating purely secondary material is added to the production of the regular refining companies, the contribution from plants in the United States to the world's supply of copper for 1922 is found to be 2,030,459,000 pounds.

## SECONDARY COPPER.

Under secondary copper is considered material recovered from remelting old copper, copper scraps, and copper recovered from the treatment of copper alloys or alloys that are treated without the separation of the copper. A canvass of plants producing secondary copper has been made by J. P. Dunlop, of the United States Geological Survey, and the following figures are taken from his report.

*Secondary copper recovered in 1922, in short tons.*

| | | |
|---|---|---|
| Copper as metal | | 113,400 |
| Copper in alloys other than brass | | 30,700 |
| | | 144,100 |
| From new scrap | | 25,300 |
| From old scrap | | 118,800 |
| | | 144,100 |
| Brass scrap melted: | | |
| New clean scrap | | 154,000 |
| Old scrap | | 120,000 |
| | | 274,000 |

| | |
|---|---|
| Copper content of brass scrap (averaging about 70 per cent copper): | |
| New scrap | 107,800 |
| Old scrap | 84,000 |
| | 191,800 |
| Total copper produced from secondary sources: | |
| From new scrap | 133,100 |
| From old scrap | 202,800 |
| | 335,900 |
| Exports of scrap brass in 1922 | 3,147 |
| Exports of scrap copper in 1922 | 1,400 |
| Imports of scrap brass in 1922 | 71,962 |
| Imports of scrap copper in 1922 | 10,675 |

In addition to the secondary material treated by the regular refining companies, plants that treated secondary material exclusively produced a total of about 525,790,000 pounds of copper as copper and in brass and other alloys of copper, making a total production of 671,800,000 pounds from secondary sources. Of this total at least 266,200,000 pounds was produced by remelting clean scrap produced in the manufacture of copper and brass articles.

*Refined copper from secondary sources produced in the United States, 1917–1922, in pounds.*

| | | | |
|---|---|---|---|
| 1917 | 766,800,000 | 1920 | 624,920,000 |
| 1918 | 705,340,000 | 1921 | 434,600,000 |
| 1919 | 574,380,000 | 1922 | 671,800,000 |

## COPPER SULPHATE.

The production of hydrous copper sulphate or bluestone by the copper refineries of the United States in 1922 was 33,402,515 pounds, having a copper content of 8,508,000 pounds, as against 26,097,993 pounds, having a copper content of 6,646,000 pounds in 1921.

## STOCKS.

*Stocks of copper January 1, 1918–1923, in pounds.*

| Year. | Refined copper. | Blister and material in process of refining. | Year. | Refined copper. | Blister and material in process of refining. |
|---|---|---|---|---|---|
| 1918 | 114,000,000 | 411,000,000 | 1921 | 659,000,000 | 465,000,000 |
| 1919 | 180,000,000 | 562,600,000 | 1922 | 459,000,000 | 283,000,000 |
| 1920 | 631,000,000 | 273,000,000 | 1923 | 216,000,000 | 361,000,000 |

## IMPORTS AND EXPORTS.

The quantity of copper in unmanufactured form imported into the United States in 1922 was 541,013,220 pounds, according to the records of the Bureau of Foreign and Domestic Commerce. The imports in 1921 were 350,472,611 pounds.

*Copper imported into the United States in 1921 and 1922, by countries, in pounds.*

[General imports.]

| Country. | Ore (copper content). | Concentrates (copper content). | Matte and regulus (copper content). | Unrefined black copper and copper in bars, pigs, or other forms. | Refined in bars, plates, rods, or other forms. | Old and clippings for remanufacture. | Composition metal, copper chief value. |
|---|---|---|---|---|---|---|---|
| **1921.** | | | | | | | |
| United Kingdom | 347,506 | ..... | 26,400 | 3,721,557 | 12,404 | 1,216,687 | 484,151 |
| France | 647,591 | ..... | 209,755 | 2,870,093 | 3,785,138 | 113,363 | 90,916 |
| Germany | 2,693,084 | ..... | 3,844,157 | 5,207,032 | 95,032 | 60,345 | 294,653 |
| Spain | 4,475,091 | ..... | 688,905 | 7,000 | ..... | 220,792 | ..... |
| Canada | 2,495,612 | 723,271 | 402,385 | 22,073,731 | 80,477 | 3,715,472 | ..... |
| Mexico | 439,539 | 10,104,379 | 3,866,319 | 16,450,113 | 51,581 | 419 | ..... |
| Cuba | 7,293,930 | 10,662,517 | ..... | ..... | ..... | 84,661 | ..... |
| Bolivia | 1,380,182 | ..... | ..... | ..... | ..... | ..... | ..... |
| Chile | 29,630,105 | 8,821,689 | 3,408,973 | 39,242,226 | 62,312,518 | ..... | ..... |
| Peru | 2,928,806 | 450,319 | 740,782 | 72,016,068 | ..... | ..... | ..... |
| Venezuela | 1,383,377 | ..... | 173,665 | ..... | ..... | 8,676 | ..... |
| Australia | ..... | ..... | ..... | 4,490,799 | ..... | ..... | ..... |
| British South Africa | 1,256,602 | ..... | 1,200,348 | ..... | 460,852 | ..... | ..... |
| Portuguese Africa | 309,344 | ..... | ..... | 4,890,520 | 2,364,026 | ..... | ..... |
| Other countries | 1,397,179 | 12,171 | 785,937 | 766,140 | 87,253 | 286,481 | 111,515 |
| | 56,677,948 | 30,774,346 | 15,347,626 | 171,735,279 | 69,249,281 | 5,706,896 | 981,235 |
| **1922.** | | | | | | | |
| United Kingdom | 2,396,043 | 1,737,707 | 119,575 | 23,241,088 | 2,739,701 | 11,556,767 | 719,034 |
| France | 168,591 | 5,980 | 394,277 | 532,003 | 3,145,752 | 4,704,910 | ..... |
| Germany | 1,114,096 | ..... | 1,591,619 | ..... | 708,514 | 277,153 | 175,662 |
| Spain | 7,001,731 | ..... | 70,000 | 13,916,628 | ..... | ..... | ..... |
| Canada | 2,567,149 | 696,296 | 283,703 | 46,211,714 | 7,532 | 3,522,162 | 2,810 |
| Mexico | 675,196 | 11,488,503 | 3,020,642 | 46,015,417 | 47,326 | 7,508 | ..... |
| Cuba | 9,220,800 | 16,056,822 | ..... | ..... | ..... | 683,393 | 9,111 |
| Bolivia | 436,153 | 643,907 | 345 | 884,622 | 20,312 | 18,745 | 31 |
| Chile | 44,041,453 | 2,073,710 | 142,261 | 44,215,265 | 96,433,739 | 103,784 | ..... |
| Peru | 1,013,165 | 104,646 | 500,340 | 81,853,488 | 19,113 | 39,113 | ..... |
| Venezuela | 901,421 | ..... | 1,236,482 | ..... | ..... | 7,974 | ..... |
| Australia | 24,408 | ..... | ..... | 1,850 | ..... | ..... | ..... |
| British South Africa | 15,700 | 24,584 | ..... | ..... | ..... | 30,899 | ..... |
| Portuguese Africa | ..... | 27,494 | ..... | 44,398,268 | ..... | ..... | ..... |
| Other countries | 1,627,220 | 48,022 | 1,368,795 | 1,308,885 | 21,153 | 389,007 | 203,951 |
| | 71,203,126 | 32,907,671 | 8,728,039 | 302,579,228 | 103,143,142 | 21,341,415 | 1,110,599 |

*Copper (in unmanufactured form) imported into the United States, 1917–1922, in pounds.*

[General imports.]

| | | | |
|---|---|---|---|
| 1917 | 556,420,297 | 1920 | 485,670,691 |
| 1918 | 575,805,115 | 1921 | 350,472,611 |
| 1919 | 429,387,594 | 1922 | 541,013,220 |

The exports of metallic copper (exclusive of ore, concentrates, and composition metal) from the United States in 1922 amounted to 742,755,957 pounds, according to the Bureau of Foreign and Domestic Commerce.

*Copper exported from the United States, 1917–1922.*

| Year. | Pounds. | | Total value. |
|---|---|---|---|
| | Metallic.[a] | Total. | |
| 1917 | 1,125,647,336 | 1,132,832,663 | $338,723,756 |
| 1918 | 744,243,481 | 747,689,580 | 195,840,637 |
| 1919 | 515,595,019 | 516,627,775 | 117,417,055 |
| 1920 | 623,158,489 | 624,053,701 | 127,468,606 |
| 1921 | 628,415,714 | 628,804,750 | 85,351,928 |
| 1922 | 742,755,957 | 743,039,888 | 103,874,007 |

[a] Exclusive of ore, concentrates, and composition metal.

*Copper sulphate (blue vitriol) exported from the United States, 1917–1922.*

| Year. | Pounds. | Value. | Year. | Pounds. | Value. |
|---|---|---|---|---|---|
| 1917 | 29,068,748 | $3,038,380 | 1920 | 3,783,409 | $306,899 |
| 1918 | 14,477,339 | 1,395,946 | 1921 | 3,582,933 | 217,491 |
| 1919 | 9,140,673 | 928,291 | 1922 | 5,250,556 | 256,432 |

*Copper exported from the United States, 1921–22, by kind and destination, in pounds.*

**1921.**

| Destination. | Ore (copper content). | Concentrates, matte and regulus (copper content). | Unrefined black copper and copper in bars, pigs or other forms. | Refined, in bars, ingots, rods,[a] or other forms. | Composition metal, copper chief value. | Old and scrap. | Pipes and tubes. | Plates and sheets. | Wire (except insulated). | Rods.[b] | Insulated wire and cable. | Other manufactures of. | Total. |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| United Kingdom | ..... | ..... | ..... | 62,334,868 | ..... | ..... | ..... | 213,184 | 1,964,232 | 6,559,714 | (c) | (c) | 71,071,998 |
| Belgium | ..... | ..... | ..... | 26,619,837 | ..... | ..... | ..... | ..... | 2,887 | ..... | | | 26,622,724 |
| Denmark | ..... | ..... | ..... | 2,331,630 | ..... | ..... | ..... | ..... | 5,450 | 2,016,584 | | | 4,353,664 |
| France | ..... | ..... | 22,408 | 98,731,640 | ..... | ..... | 800 | 448,020 | 56,564 | ..... | | | 99,259,432 |
| Germany | ..... | ..... | ..... | 233,072,479 | ..... | ..... | ..... | 224,040 | ..... | 221,185 | | | 233,520,704 |
| Italy | ..... | ..... | ..... | 16,369,962 | ..... | ..... | ..... | 44,775 | 114,472 | ..... | | | 16,529,209 |
| Netherlands | ..... | ..... | ..... | 28,646,940 | ..... | ..... | ..... | 11,648 | 98,637 | 210,175 | | | 28,967,400 |
| Norway | ..... | ..... | ..... | 970,036 | ..... | ..... | ..... | ..... | 2,004,222 | 441,670 | | | 3,415,928 |
| Spain | ..... | ..... | ..... | 8,403,156 | ..... | ..... | 7,974 | 141,897 | 366,216 | ..... | | | 8,919,243 |
| Sweden | ..... | ..... | ..... | 8,755,398 | ..... | 2,960 | ..... | ..... | 9,360 | 44,910 | | | 8,812,628 |
| Switzerland | ..... | ..... | ..... | 67,200 | ..... | ..... | ..... | 23,344 | 112,000 | ..... | | | 202,544 |
| Other Europe | ..... | ..... | ..... | 2,190,511 | ..... | ..... | ..... | 16,434 | 1,098,294 | ..... | | | 3,305,239 |
| Canada | 299,150 | ..... | 121,863 | 7,198,649 | 15,374 | 248,654 | 831,775 | 1,735,508 | 176,785 | 3,256,976 | | | 13,884,734 |
| China | ..... | ..... | ..... | 37,040,754 | ..... | ..... | 2,197 | 11,259 | 80,650 | ..... | | | 37,134,860 |
| Japan | ..... | ..... | ..... | 59,170,325 | ..... | 357,859 | ..... | ..... | 119,456 | ..... | | | 59,647,640 |
| Other countries | ..... | 60,970 | 6,042 | 4,213,862 | 13,542 | 6,473 | 1,405,757 | 2,235,807 | 5,197,772 | 16,578 | | | 13,156,803 |
| | 299,150 | 60,970 | 150,313 | 596,117,247 | 28,916 | 615,946 | 2,248,503 | 5,105,916 | 11,406,997 | 12,770,792 | | | 628,804,750 |

| | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| United Kingdom | 1,332 | 56,107 | 73,528,982 | 143,252 | 186,500 | 16,075 | 386,973 | 1,345,867 | 20,808,602 | 137,303 | 1,105,700 | 97,716,693 |
| Belgium | | 112,030 | 41,866,516 | | 11,494 | | 224,075 | 1,520 | | 1,262 | 529,458 | 42,746,355 |
| Denmark | | | 1,019,233 | | | | 1,170 | | 5,974,411 | 18,774 | 2,425 | 7,016,013 |
| France | | | 135,406,760 | | 67,165 | | | 149,413 | 112,009 | 36,188 | 1,276,900 | 137,048,435 |
| Germany | 22,464 | | 190,348,952 | 550 | 470,715 | 123 | 164,295 | 128,436 | 2,133,986 | | 527,829 | 193,797,350 |
| Italy | | | 53,852,337 | | | | 564 | 135,160 | | 35,778 | 304 | 54,024,143 |
| Netherlands | | | 30,451,269 | | | 5,473 | 7,582 | 319,133 | 773,293 | 6,094 | 275,401 | 31,838,245 |
| Norway | | | 347,809 | | | 10,116 | 110 | 1,233,726 | 917,811 | 229,170 | 63 | 2,738,805 |
| Spain | | | 11,373,402 | 1,100 | | | 345 | 93,738 | | 7,277 | 16,188 | 11,492,050 |
| Sweden | | | 20,127,664 | | | | | 99,757 | 190,548 | 10,568 | 1,546 | 20,430,083 |
| Switzerland | | | 593,972 | | | 515 | | 1,000 | 110,000 | 279 | 1,145 | 706,911 |
| Other Europe | | | 874,798 | | | 30 | 2,797 | 56,701 | 65 | 13,497 | 637 | 948,525 |
| Canada | 26,006 | 1,596 | 3,137,748 | 27,726 | 1,458,716 | 843,657 | 1,962,731 | 423,848 | 20,915,397 | 638,876 | 1,453,639 | 30,889,940 |
| British India | 735 | | 5,061,526 | | | 1,925 | 2,452,154 | 407,586 | 42 | 114,575 | 22,433 | 8,060,976 |
| China | | | 42,379,643 | 20,800 | | 883 | 7,667 | 430,633 | 116 | 466,144 | 21,252 | 43,327,138 |
| Japan | 11,620 | | 38,855,814 | | 590,317 | 99 | 832 | 272,837 | | 763,835 | 10,511 | 40,505,865 |
| Other countries | 301 | | 3,440,514 | 28,045 | 15,955 | 943,684 | 1,537,159 | 6,591,125 | 252,316 | 6,096,125 | 937,137 | 19,752,361 |
| | 62,458 | 169,733 | 652,666,939 | 221,473 | 2,800,862 | 1,822,580 | 6,748,454 | 11,600,480 | 52,188,596 | 8,575,745 | 6,182,568 | 743,039,888 |

[a] Rods separately classified after July 1, 1921.
[b] Rods included under "Refined, in ingots, bars, rods ,or other forms" prior to July 1, 1921, when separate classification was made..
[c] Not separately classified prior to 1922.

*Brass and bronze exported from the United States in 1922.*

| | Pounds. | Value. |
|---|---|---|
| Scrap and old | 6,293,743 | $514,322 |
| Ingots, bars, rods, plates, and sheets | 3,660,340 | 635,449 |
| Cartridge shells, empty | 79,395 | 34,221 |
| Pipes and tubes | 2,845,174 | 590,245 |
| Pipe fittings, valves, faucets, etc | 2,303,890 | 1,232,585 |
| Builders' hardware of brass or bronze | 219,893 | 158,123 |
| Wire of brass or bronze | 1,230,307 | 344,281 |
| Other brass manufactures | 4,052,433 | 2,255,996 |
| Other bronze manufactures | 1,313,242 | 641,448 |
| | 21,998,417 | 6,406,670 |

*Unmanufactured brass exported from the United States, 1917–1922.*

(Ingots, bars, rods, plates, and sheets.)

| Year. | Pounds. | Value. | Year. | Pounds. | Value. |
|---|---|---|---|---|---|
| 1917 | 328,346,666 | $101,521,426 | 1920 | 5,810,733 | $1,671,608 |
| 1918 | 30,989,717 | 9,522,934 | 1921 | 2,874,762 | 741,110 |
| 1919 | 7,770,671 | 2,310,561 | 1922 | 3,660,340 | 635,449 |

## CONSUMPTION.

The refined new copper withdrawn from the total year's supply on domestic account in 1922 was 897,000,000 pounds; in 1921 it was 611,000,000 pounds. The method employed in determining the quantity of copper retained for consumption is shown in the following table, which does not include stocks of copper held by consumers:

*New refined copper withdrawn from total year's supply on domestic account,[a] 1913 and 1918–1922, in pounds.*

| | 1913 | 1918 | 1919 |
|---|---|---|---|
| Total supply of new copper | 1,615,067,782 | 2,432,385,290 | 1,805,306,801 |
| Stock at beginning of year | 105,497,683 | 114,000,000 | 180,000,000 |
| Total available supply | 1,720,565,465 | 2,546,385,290 | 1,985,306,801 |
| Copper exported [b] | 817,911,424 | 704,715,714 | 439,835,229 |
| Stock at end of year | 90,385,402 | 180,000,000 | 631,000,000 |
| Total withdrawn from supply | 908,296,826 | 884,715,714 | 1,070,835,229 |
| Withdrawn on domestic account | 812,268,639 | 1,661,669,576 | 914,471,572 |

| | 1920 | 1921 | 1922 |
|---|---|---|---|
| Total supply of new copper | 1,634,908,644 | 1,020,027,096 | 1,358,659,101 |
| Stock at beginning of year | 631,000,000 | 659,000,000 | 459,000,000 |
| Total available supply | 2,265,908,644 | 1,679,027,096 | 1,817,659,101 |
| Copper exported [b] | 553,070,086 | 609,038,352 | 705,025,268 |
| Stock at end of year | 659,000,000 | 459,000,000 | 216,000,000 |
| Total withdrawn from supply | 1,212,070,086 | 1,068,038,352 | 921,025,268 |
| Withdrawn on domestic account | 1,053,838,558 | 610,988,744 | 896,633,833 |

[a] In reports prior to 1920 called "Apparent domestic consumption."
[b] Includes unrefined black blister and converter copper (bars, pigs, and other forms) and refined in ingots, bars, rods, or other forms.

If to the 896,600,000 pounds of new refined copper is added the 671,800,000 pounds of secondary copper and copper in alloys produced during the year, it is found that a total of about 1,568,400,000 pounds of new and old copper was available for domestic consumption.

As may be seen from the method of calculation, the figures represent the quantity of new copper withdrawn from supply on domestic account but not actual domestic consumption, as they take no account of consumers' stocks. Furthermore, much of the copper exported is in manufactured forms; consequently much of the copper bought on domestic account during any year is exported in manufactured forms at a later date. As the records of the Bureau of Foreign and Domestic Commerce do not separate refined manufactured and unmanufactured copper, no close calculation of actual domestic consumption can be made.

## USES.

There are no data available showing the quantity of copper that entered the different industries, and the great changes due to the war render any estimate more uncertain than usual.

The following table shows the copper cast in different forms in 1922. It will be noted that the total is not the same as the production of refined copper.

*Copper cast in different forms in 1922.*

| Form. | Pounds. | Percentage. |
|---|---|---|
| Wire bars | 858,000,000 | 60.81 |
| Ingots | 253,000,000 | 17.93 |
| Cakes | 193,000,000 | 13.68 |
| Cathodes | 37,000,000 | 2.62 |
| Other forms | 70,000,000 | 4.96 |
| | 1,411,000,000 | 100.00 |

## PRICES.

The average price received for copper delivered by the producers in 1922 and the price used by the United States Geological Survey in calculating the value of the copper output was 13.5 cents a pound. The average received by selling agencies for 1,913,000,000 pounds, as reported to the Geological Survey by the agencies, was 13.4665 cents a pound.

*Price per pound of copper, 1850–1922.*[1]

| | | | | | |
|---|---|---|---|---|---|
| 1850 | $0.22 | 1862 | $0.22 | 1874 | $0.220 |
| 1851 | .166 | 1863 | .34 | 1875 | .227 |
| 1852 | .22 | 1864 | .47 | 1876 | .21 |
| 1853 | .22 | 1865 | .392 | 1877 | .19 |
| 1854 | .22 | 1866 | .342 | 1878 | .166 |
| 1855 | .27 | 1867 | .254 | 1879 | .186 |
| 1856 | .27 | 1868 | .23 | 1880 | .214 |
| 1857 | .25 | 1869 | .242 | 1881 | .182 |
| 1858 | .23 | 1870 | .212 | 1882 | .191 |
| 1859 | .22 | 1871 | .241 | 1883 | .165 |
| 1860 | .23 | 1872 | .356 | 1884 | .13 |
| 1861 | .22 | 1873 | .280 | 1885 | .108 |

[1] Weed, W. H., Copper Handbook, vol. 11, pp. 1339, 1343, for years 1850–1903. By computation from data for years 1850–1860, p. 1339. Survey computations for electrolytic copper since 1904. For 1916 and later years average price all marketable grades.

| | | | | | |
|---|---|---|---|---|---|
| 1886 | $0.111 | 1899 | $0.171 | 1912 | $0.165 |
| 1887 | .138 | 1900 | .166 | 1913 | .155 |
| 1888 | .168 | 1901 | .167 | 1914 | .133 |
| 1889 | .135 | 1902 | .122 | 1915 | .175 |
| 1890 | .156 | 1903 | .137 | 1916 | .246 |
| 1891 | .128 | 1904 | .128 | 1917 | .273 |
| 1892 | .116 | 1905 | .156 | 1918 | .247 |
| 1893 | .108 | 1906 | .193 | 1919 | .186 |
| 1894 | .095 | 1907 | .20 | 1920 | .184 |
| 1895 | .107 | 1908 | .132 | 1921 | .129 |
| 1896 | .108 | 1909 | .13 | 1922 | .135 |
| 1897 | .12 | 1910 | .127 | | |
| 1898 | .124 | 1911 | .125 | | |

The average price for copper for the last 20 years as reported to the Geological Survey by selling agencies has been 17.9243 cents a pound, compared with an average price during 1922 of 13.5 cents.

*Average monthly prices at New York per pound of electrolytic copper in 1917–1922, in cents, as reported by the American Metal Market Co.*

| Month. | 1917 | 1918 | 1919 | 1920 | 1921 | 1922 |
|---|---|---|---|---|---|---|
| January | 30.26 | 23.50 | 20.05 | 19.02 | 12.85 | 13.60 |
| February | 35.22 | 23.50 | 16.91 | 18.61 | 12.79 | 12.97 |
| March | 35.74 | 23.50 | 15.01 | 18.36 | 12.23 | 12.84 |
| April | 32.19 | 23.50 | 15.40 | 18.54 | 12.54 | 12.71 |
| May | 32.32 | 23.50 | 16.005 | 18.28 | 12.83 | 13.29 |
| June | 32.57 | 23.50 | 17.655 | 17.97 | 12.76 | 13.71 |
| July | 28.90 | 25.89 | 21.71 | 18.61 | 12.35 | 13.90 |
| August | 27.13 | 26.00 | 22.22 | 18.44 | 11.76 | 13.96 |
| September | 25.45 | 26.00 | 21.95 | 18.04 | 12.105 | 13.88 |
| October | 23.50 | 26.00 | 21.505 | 16.30 | 12.75 | 13.80 |
| November | 23.50 | 26.00 | 19.96 | 14.39 | 13.16 | 13.79 |
| December | 23.50 | 25.285 | 18.48 | 13.48 | 13.67 | 14.22 |
| Average | 29.19 | 24.68 | 18.905 | 17.50 | 12.65 | 13.56 |

*Average monthly quoted prices at New York per pound of electrolytic copper in 1917–1922, in cents, as reported by the Engineering and Mining Journal.*

| Month. | 1917 | 1918 | 1919 | 1920 | 1921 | 1922 |
|---|---|---|---|---|---|---|
| January | 28.673 | 23.50 | (a) | 18.918 | 12.597 | 13.465 |
| February | 31.750 | 23.50 | 16.763 | 18.569 | 12.556 | 12.864 |
| March | 31.481 | 23.50 | 14.856 | 18.331 | 11.976 | 12.567 |
| April | 27.935 | 23.50 | 15.246 | 18.660 | 12.438 | 12.573 |
| May | 28.788 | 23.50 | 15.864 | 18.484 | 12.742 | 13.111 |
| June | 29.962 | 23.50 | 17.610 | 18.065 | 12.697 | 13.575 |
| July | 26.620 | 25.904 | 21.604 | 18.576 | 12.170 | 13.654 |
| August | 25.380 | 26.00 | 22.319 | 18.346 | 11.634 | 13.723 |
| September | 25.073 | 26.00 | 21.755 | 18.144 | 11.948 | 13.748 |
| October | 23.500 | 26.00 | 21.534 | 15.934 | 12.673 | 13.632 |
| November | 23.500 | 26.00 | 19.758 | 14.257 | 13.035 | 13.598 |
| December | 23.500 | (a) | 18.295 | 13.138 | 13.555 | 14.074 |
| Average | 27.180 | 24.628 | 18.691 | 17.456 | 12.502 | 13.382 |

[a] No market.

# GOLD, SILVER, COPPER, LEAD, AND ZINC IN NEVADA.

(MINES REPORT.)

By V. C. Heikes.[1]

## PRODUCTION.

The output of all metals except gold produced in Nevada increased in 1922 in both quantity and value. The value of the metal output, however, was only half that of the average yearly output of the last ten years. Five mining companies paid dividends in 1922 amounting to $1,124,972.

*Mine production of gold, silver, copper, lead, and zinc in Nevada in 1921 and 1922.*

| Year. | Number of producers. | Ore. | Gold.[a] | Silver.[a] | Copper. | Lead. | Recoverable zinc. | Total value. |
|---|---|---|---|---|---|---|---|---|
| | | *Short tons.* | | *Fine ounces.* | *Pounds.* | *Pounds.* | *Pounds.* | |
| 1921 | 431 | 1,096,138 | $3,312,757 | 7,083,782 | 10,961,491 | 7,188,768 | 69,397 | $12,137,536 |
| 1922 | 387 | 1,565,276 | 3,297,384 | 8,619,587 | 23,133,091 | 9,389,182 | 2,618,710 | 15,705,609 |
| Increase or decrease, 1922 | −44 | +469,138 | −15,373 | +1,535,805 | +12,171,600 | +2,200,414 | +2,549,313 | +3,568,073 |
| Total 1904–1922 | ..... | 62,161,341 | 182,876,448 | 196,553,027 | 997,170,832 | 238,116,821 | 175,103,170 | 534,777,170 |

[a] Includes placer production.

## THE TREND OF MINING IN NEVADA.

The mining of ore in Nevada has been characterized by sudden spurts of high production, and in 63 years more than 76,000,000 tons of ore, valued at more than $1,000,000,000 for its content of gold, silver, lead, copper, and zinc, has been mined. Before there was much ore mined elsewhere in Nevada than on the Comstock lode the annual output was not important until 1863, when 250,000 tons of ore was produced. The miners on the Comstock lode steadily increased their output and in 1876 reached a maximum production of 598,818 tons, which, added to that of the Eureka, Pioche, and other mining districts, made a total of 703,000 tons for the State. Mining in Nevada was active until 1882, when production dropped to about 225,000 tons; the output increased to 362,000 tons in 1889 and dropped to 88,000 tons in 1893. No great change in production then took place until 1901, when the mines were opened at Tonopah.

[1] Valuable assistance in the preparation of this report and the compilation of the statistical tables has been rendered by B. N. Patchell, of the United States Geological Survey.

In 1902 ore was found at Goldfield. These new discoveries stimulated mining considerably, and ore production soon increased, amounting to 323,000 tons in 1904. In 1908 the low-grade copper ore mined at Ely by steam shovels immediately added nearly half a million tons of ore to the yearly output. The maximum total for the State was 6,473,000 tons in 1917. A curtailment of copper production caused a sudden drop from 3,480,000 tons in 1920 to about 1,100,000 tons in 1921, but a good recovery was noted in 1922.

The placer bullion won in Nevada during the last 13 years amounted to $3,435,696 in gold and 65,690 ounces of silver, most of which was produced from Battle Mountain, Manhattan, and Round Mountain drift and surface placer deposits. Little is known of the early placer operations, and the output of the placers now operated will probably slowly decrease.

Since 1901 the output of siliceous ore, containing principally silver, has come from mines at Tonopah and later at Goldfield, thus supplanting the earlier output of the Comstock lode. In 1919 there was a considerable decrease, and in 1922 only a slight recovery in the output was noted. The loss may possibly be counteracted by renewed activity in the Comstock district, which started in 1922 (p. 336).

Silver became of importance in Nevada in 1860 and at that time was apparently the only silver produced in the United States, according to data compiled by Raymond.[2] The output of the Comstock increased rapidly to 1877, when it attained 78,000,000 ounces. The decline in price had begun in 1875, and in the year of maximum output the price had fallen considerably. In 1892 silver production was again disturbed. On the eve of the lowest recorded price of 47 cents in 1902, Tonopah was born. The district thrived with silver at 66 cents in 1907, but many properties in Nevada whose silver ore was of lower grade were compelled to close the following year, when the price of silver averaged 53 cents an ounce.

In 1918 the Pittman Act was passed, providing for the purchase of silver from domestic mines at $1 an ounce. Ore that had previously been too low in silver to treat profitably was reduced at mills and smelters, but a serious decline took place in siliceous ores, as shown by the table on page 308, even during the operation of the Pittman Act.

The output of the younger mining districts, compared with that of the famous Comstock region, noted in the sixties for its bonanza ore deposits of silver, is of interest. The Comstock district proved extremely rich but, together with Eureka, Tuscarora, and Pioche, was rapidly exhausted in the seventies. For 20 years, from 1883 to 1903, the output of gold and silver in Nevada was comparatively small, though all that was needed to stimulate prospecting was the finding of other bonanza deposits, such as those subsequently opened at Tonopah and Goldfield in 1903 and 1904. These discoveries brought on another increase in production of gold and silver, which from 1901 to the end of 1922 amounted to $114,281,916 in gold and 96,284,471 ounces of silver, valued together at $210,566,387. The output of Tonopah and Goldfield for this period compares with the production of the Comstock region from 1859 to the end of 1878—approximately $118,514,682 in gold and 170,277,019 ounces of silver.

[2] Raymond, R. W., Mineral resources of the States and Territories west of the Rocky Mountains for 1875, p. 377, 1876.

All the above-mentioned output, covering periods of about 20 years in each region, came from quartzose gold and silver ores, the total value of which amounted to about $500,000,000.

The Robinson and Yerington districts are the source of most of the copper in Nevada. Yerington produced considerable copper from 1912 to 1920, but the mines were inactive after 1920. The maximum State output of copper was 122,794,704 pounds in 1917, of which the Robinson district produced 93,627,420 pounds.

Lead ore from the mines at Pioche was once a factor in the total output of the United States. These mines held an important position as lead producers from 1870 to 1875, but thereafter their production declined. Two years later the lead output was increased by the mines of Eureka, which made a considerable production between 1877 and 1881. The maximum output recorded between 1870 and 1883 was 62,126,000 pounds in 1878. In the last 13 years the maximum output was 27,678,000 pounds of lead in 1917, produced principally from the Pioche and Yellow Pine districts. Copper-lead ores have been important only in Lincoln, Elko, and White Pine counties.

Shipments of zinc ore and lead-zinc ore, principally from mines in the Yellow Pine district, began in 1905, and the output of zinc from such ores to the end of 1922 amounted to 175,000,000 pounds. The record output was 32,400,000 pounds in 1916, and with zinc sufficiently high in price this output may be equaled again.

The following tables give the production of the State in the last 13 years, together with a separation of the output by kinds of ore:

*Mine production of gold, silver, copper, lead, and zinc in Nevada, 1910–1922.*

| Year. | Ore. | Gold. | Silver. | Copper. | Lead. | Zinc. | Total value. |
|---|---|---|---|---|---|---|---|
| | *Short tons.* | *Fine ounces.* | *Fine ounces.* | *Pounds.* | *Pounds.* | *Pounds.* | |
| 1910 | 3,655,775 | 913,265.05 | 12,479,871 | 64,359,398 | 4,871,130 | 2,707,071 | $34,152,148 |
| 1911 | 4,132,721 | 880,105.58 | 13,184,601 | 67,377,518 | 3,263,657 | 3,548,032 | 33,952,529 |
| 1912 | 4,763,965 | 650,942.71 | 14,369,063 | 86,477,494 | 19,500,100 | 13,322,988 | 38,358,732 |
| 1913 | 5,367,211 | 570,589.41 | 16,090,083 | 90,693,751 | 16,344,023 | 14,419,671 | 37,097,710 |
| 1914 | 4,522,022 | 555,402.47 | 15,455,491 | 60,986,450 | 12,809,655 | 12,980,232 | 29,300,842 |
| 1915 | 5,118,620 | 551,683.01 | 14,459,840 | 68,636,370 | 16,637,277 | 24,376,450 | 34,551,436 |
| 1916 | 5,941,165 | 428,904.21 | 13,837,525 | 105,116,813 | 25,637,278 | 32,443,189 | 49,946,424 |
| 1917 | 6,473,519 | 336,664.26 | 11,269,969 | 122,794,704 | 27,677,928 | 22,307,868 | 54,424,580 |
| 1918 | 6,472,579 | 320,239.45 | 10,000,599 | 116,316,441 | 23,316,534 | 16,724,753 | 48,528,124 |
| 1919 | 3,187,831 | 219,695.16 | 6,863,580 | 52,331,175 | 15,349,370 | 9,004,698 | 23,433,171 |
| 1920 | 3,480,620 | 172,540.46 | 7,745,093 | 50,559,763 | 21,263,700 | 10,698,040 | 23,879,512 |
| 1921 | 1,096,138 | 160,254.62 | 7,083,782 | 10,961,491 | 7,188,768 | 69,397 | 12,137,536 |
| 1922 | 1,565,276 | 159,510.95 | 8,619,587 | 23,133,091 | 9,389,182 | 2,618,710 | 15,705,609 |
| | 55,777,442 | 5,919,797.34 | 151,459,084 | 919,744,459 | 203,248,602 | 165,221,099 | 435,468,353 |

*Gold and silver produced by placer mines in Nevada, 1910–1922, in fine ounces.*

| Year | Gold. | Silver. | Year. | Gold. | Silver. |
|---|---|---|---|---|---|
| 1910 | 7,854.70 | 3,655 | 1918 | 10,564.13 | 3,907 |
| 1911 | 10,181.05 | 4,536 | 1919 | 6,399.43 | 2,374 |
| 1912 | 11,206.22 | 4,474 | 1920 | 7,383.91 | 3,296 |
| 1913 | 14,775.75 | 6,363 | 1921 | 17,566.99 | 7,956 |
| 1914 | 18,250.05 | 6,367 | 1922 | 11,602.36 | 4,710 |
| 1915 | 19,123.55 | 6,030 | | | |
| 1916 | 17,139.89 | 5,744 | | 166,201.78 | 65,690 |
| 1917 | 14,153.75 | 6,278 | | | |

*Content of ore sold or treated in Nevada, 1910–1922.*

**Dry and siliceous ore.**

| Year. | Ore. | Gold. | Silver. | Copper. | Lead. |
|---|---|---|---|---|---|
| | *Short tons.* | *Fine ounces.* | *Fine ounces.* | *Pounds.* | *Pounds.* |
| 1910 | 1,258,394 | 880,180.93 | 11,763,612 | 109,073 | 185,032 |
| 1911 | 1,341,495 | 847,124.81 | 12,830,194 | 55,134 | 139,324 |
| 1912 | 1,400,728 | 608,132.86 | 13,135,677 | 594,973 | 2,053,789 |
| 1913 | 1,616,826 | 511,402.36 | 15,245,541 | 21,400 | 4,390,205 |
| 1914 | 1,594,486 | 484,796.50 | 14,724,094 | 27,533 | 4,346,742 |
| 1915 | 1,812,653 | 466,358.56 | 13,808,912 | 11,688 | 7,183,878 |
| 1916 | 1,688,661 | 351,420.33 | 12,751,911 | 167,186 | 8,104,649 |
| 1917 | 1,413,929 | 268,671.85 | 10,176,717 | 69,231 | 7,193,631 |
| 1918 | 1,394,583 | 257,063.06 | 9,152,376 | 70,634 | 5,516,226 |
| 1919 | 783,567 | 194,008.03 | 6,306,583 | 191,763 | 5,987,127 |
| 1920 | 799,207 | 136,058.51 | 6,939,579 | 168,534 | 5,789,125 |
| 1921 | 667,560 | 133,294.94 | 6,539,514 | 229,989 | 1,574,307 |
| 1922 | 871,883 | 140,506.36 | 7,809,857 | 146,038 | 922,499 |
| | 16,643,972 | 5,279,019.10 | 141,183,967 | 1,863,176 | 53,386,534 |

**Copper ore.**

| | | | | | |
|---|---|---|---|---|---|
| 1910 | 2,375,490 | 21,230.87 | 107,365 | 64,151,251 | 24,813 |
| 1911 | 2,778,325 | 21,841.27 | 111,474 | 67,286,120 | ..... |
| 1912 | 3,276,169 | 23,511.60 | 173,545 | 85,579,530 | 31,180 |
| 1913 | 3,698,255 | 39,109.98 | 241,756 | 90,117,754 | 2,097 |
| 1914 | 2,882,121 | 49,476.59 | 181,733 | 60,398,084 | 14,395 |
| 1915 | 3,247,140 | 63,043.85 | 244,643 | 68,435,787 | 58,022 |
| 1916 | 4,146,956 | 56,880.78 | 384,393 | 104,599,510 | 59,675 |
| 1917 | 4,945,482 | 49,419.80 | 327,751 | 122,422,830 | 20,876 |
| 1918 | 4,994,804 | 49,186.44 | 278,615 | 116,109,020 | 69,172 |
| 1919 | 2,363,189 | 16,254.92 | 73,371 | 52,042,089 | 6,471 |
| 1920 | 2,616,237 | 22,924.19 | 82,977 | 49,858,120 | 4,871 |
| 1921 | 401,153 | 4,747.21 | 19,323 | 10,318,851 | 21 |
| 1922 | 629,408 | 4,400.63 | 17,127 | 22,640,042 | 424 |
| | 38,354,729 | 422,028.13 | 2,244,073 | 913,958,988 | 292,017 |

**Lead ore.**

| | | | | | |
|---|---|---|---|---|---|
| 1910 | 16,805 | 3,967.07 | 583,282 | 68,329 | 3,927,148 |
| 1911 | 5,018 | 895.66 | 186,485 | 11,856 | 1,718,250 |
| 1912 | 59,452 | 8,085.83 | 841,733 | 291,960 | 11,477,188 |
| 1913 | 18,976 | 2,871.40 | 313,779 | 134,905 | 5,278,045 |
| 1914 | 16,088 | 2,541.09 | 286,935 | 211,015 | 3,427,198 |
| 1915 | 15,508 | 2,463.69 | 238,420 | 51,303 | 5,222,233 |
| 1916 | 37,513 | 3,046.56 | 444,585 | 144,963 | 12,044,727 |
| 1917 | 66,614 | 3,939.81 | 556,706 | 172,265 | 15,355,354 |
| 1918 | 48,169 | 2,311.40 | 429,917 | 69,838 | 12,972,922 |
| 1919 | 19,152 | 2,481.11 | 373,518 | 71,862 | 6,121,663 |
| 1920 | 40,544 | 3,237.01 | 520,971 | 158,364 | 11,111,973 |
| 1921 | 25,597 | 4,614.98 | 496,826 | 384,739 | 5,415,434 |
| 1922 | 39,462 | 2,979.85 | 698,590 | 331,168 | 6,266,647 |
| | 408,898 | 43,435.46 | 5,971,747 | 2,102,567 | 100,338,782 |

**Copper-lead ore.**

| | | | | | |
|---|---|---|---|---|---|
| 1910 | 385 | 22.02 | 11,413 | 29,955 | 187,654 |
| 1911 | 216 | 47.60 | 9,826 | 23,644 | 73,423 |
| 1912 | 168 | 1.94 | 4,327 | 11,031 | 56,924 |
| 1913 | 6,197 | 2,424.89 | 102,042 | 418,886 | 1,541,907 |
| 1914 | 3,762 | 46.54 | 85,109 | 325,404 | 1,136,797 |
| 1915 | 1,485 | 118.52 | 34,690 | 132,154 | 435,135 |
| 1916 | 2,846 | 29.60 | 50,803 | 200,213 | 880,477 |
| 1917 | 1,158 | 263.74 | 21,967 | 127,459 | 265,113 |
| 1918 | 800 | 929.14 | 12,218 | 63,410 | 241,583 |
| 1919 | 4,996 | 511.52 | 3,345 | 24,871 | 92,413 |
| 1920 | 6,269 | 2,936.41 | 114,358 | 374,745 | 1,340,286 |
| 1921 | 1,689 | 30.50 | 20,163 | 27,912 | 154,288 |
| 1922 | 102 | 1.90 | 2,153 | 11,283 | 39,869 |
| | 30,073 | 7,364.32 | 472,414 | 1,770,967 | 6,445,869 |

*Content of ore sold or treated in Nevada, 1910–1922*—Continued.

**Zinc ore and lead-zinc ore.**

| Year. | Ore. | Gold. | Silver. | Copper. | Lead. | Recoverable zinc. |
|---|---|---|---|---|---|---|
| | *Short tons.* | *Fine ounces.* | *Fine ounces.* | *Pounds.* | *Pounds.* | *Pounds.* |
| 1910 | 4,701 | 9.46 | 11,144 | 790 | 546,483 | 2,707,071 |
| 1911 | 7,667 | 15.19 | 42,086 | 764 | 1,332,660 | 3,548,032 |
| 1912 | 27,448 | 4.26 | 209,307 | ..... | 5,881,019 | 13,322,988 |
| 1913 | 26,957 | 5.03 | 180,602 | 806 | 5,131,769 | 14,419,671 |
| 1914 | 25,565 | 291.70 | 171,253 | 24,414 | 3,884,523 | 12,980,232 |
| 1915 | 41,756 | 558.64 | 126,534 | ..... | 3,720,432 | 24,333,799 |
| 1916 | 65,189 | 387.05 | 200,089 | 4,941 | 4,547,750 | 32,443,189 |
| 1917 | 46,336 | 215.31 | 180,550 | 2,919 | 4,842,954 | 22,307,868 |
| 1918 | 34,223 | 185.28 | 123,566 | 3,539 | 4,516,631 | 16,724,753 |
| 1919 | 16,927 | 40.15 | 104,389 | 590 | 3,141,696 | 9,004,698 |
| 1920 | 18,363 | .43 | 83,912 | ..... | 3,017,445 | 10,698,040 |
| 1921 | 139 | ..... | ..... | ..... | 44,718 | 69,397 |
| 1922 | 24,421 | 19.85 | 87,150 | 4,560 | 2,159,743 | 2,618,710 |
| | 339,692 | 1,732.35 | 1,520,582 | 43,323 | 42,767,823 | 165,178,448 |

## ORE.

Silver ore was mined in Nevada in 1922 in greatest quantity, closely followed by copper ore. The total values of the ores not shown in the accompanying table are as follows: Dry gold ore, $1,285,165; dry gold and silver ore, $392,047; dry silver ore, $9,107,622; copper ore, $3,164,525; lead ore, $1,149,563; zinc ore, $37,835; copper-lead ore, $5,908; lead-zinc ore, $318,392. The placer output, valued at $244,552, makes the total for the State $15,705,609.

*Ore and metals produced in Nevada in 1922.*

| Source of production. | Ore. | | Gold. | | Silver. | |
|---|---|---|---|---|---|---|
| | Short tons. | Per cent. | Fine ounces. | Per cent. | Fine ounces. | Per cent. |
| Dry gold ore | 69,337 | 4.43 | 57,954.24 | 36.33 | 86,180 | 1.00 |
| Dry gold and silver ore | 44,503 | 2.84 | 10,189.16 | 6.39 | 167,704 | 1.95 |
| Dry silver ore | 758,043 | 48.43 | 72,362.96 | 45.37 | 7,555,973 | 87.66 |
| Copper ore | 629,408 | 40.21 | 4,400.63 | 2.76 | 17,127 | .20 |
| Lead ore | 39,462 | 2.52 | 2,979.85 | 1.87 | 698,590 | 8.11 |
| Zinc ore | 1,158 | .07 | ..... | ..... | ..... | ..... |
| Copper-lead ore | 102 | .01 | 1.90 | ..... | 2,153 | .02 |
| Lead-zinc ore | 23,263 | 1.49 | 19.85 | .01 | 87,150 | 1.01 |
| Total deep mines | 1,565,276 | 100.00 | 147,908.59 | 92.73 | 8,614,877 | 99.95 |
| Total placers | ..... | ..... | 11,602.36 | 7.27 | 4,710 | .05 |
| Total, deep and placers, 1922 | 1,565,276 | 100.00 | 159,510.95 | 100.00 | 8,619,587 | 100.00 |
| Total, deep and placers, 1921 | 1,096,138 | ..... | 160,254.62 | ..... | 7,083,782 | ..... |
| Increase or decrease, 1922 | +469,138 | ..... | −743.67 | ..... | +1,535,805 | ..... |

| Source of production. | Copper. | | Lead. | | Zinc. | |
|---|---|---|---|---|---|---|
| | Pounds. | Per cent. | Pounds. | Per cent. | Pounds. | Per cent. |
| Dry gold ore | 2,045 | 0.01 | 12,513 | 0.13 | ..... | ..... |
| Dry gold and silver ore | 67,999 | .29 | 82,443 | .88 | ..... | ..... |
| Dry silver ore | 75,994 | .33 | 827,543 | 8.81 | ..... | ..... |
| Copper ore | 22,640,042 | 97.87 | 424 | ..... | ..... | ..... |
| Lead ore | 331,168 | 1.43 | 6,266,647 | 66.74 | ..... | ..... |
| Zinc ore | ..... | ..... | 2,400 | .03 | 661,466 | 25.26 |
| Copper-lead ore | 11,283 | .05 | 39,869 | .43 | ..... | ..... |
| Lead-zinc ore | 4,560 | .02 | 2,157,343 | 22.98 | 1,957,244 | 74.74 |
| Total deep mines | 23,133,091 | 100.00 | 9,389,182 | 100.00 | 2,618,710 | 100.00 |
| Total deep mines, 1921 | 10,961,491 | ..... | 7,188,768 | ..... | 69,397 | ..... |
| Increase, 1922 | 12,171,600 | ..... | 2,200,414 | ..... | 2,549,313 | ..... |

## GOLD ORE.

The gold ores, largely dry and siliceous, were mined by 108 producers in 1922, compared with 122 producers in 1921. These ores averaged $17.28 in gold and 1.24 ounces of silver to the ton and 0.01 per cent of lead and were valued at $18.54 a ton. Nye County had the largest number of gold-ore producers—20, who reported 14,493 tons, mainly from the Manhattan district, followed by the Round Mountain district. Elko County, with only 13 producers of gold ore, had the greatest output, 42,657 tons, largely from the Jarbidge and Gold Circle districts. The largest producers of gold ore were the Elkoro mine, at Jarbidge; the White Caps, at Manhattan; the Goldfield Consolidated, at Goldfield; and the Round Mountain Mining Co., at Round Mountain.

*Content of dry gold ore sold or treated in Nevada in 1922.*

| County. | Ore. | Gold. | Silver. | Copper. | Lead. |
|---|---|---|---|---|---|
| | *Short tons.* | *Fine ounces.* | *Fine ounces.* | *Pounds.* | *Pounds.* |
| Churchill | 3 | 65.91 | 35 | | |
| Clark | 1,058 | 752.04 | 422 | | |
| Douglas | 35 | 26.26 | 12 | | |
| Elko | 42,657 | 24,118.10 | 62,300 | | |
| Esmeralda | 7,298 | 13,644.00 | 6,536 | 1,993 | |
| Eureka | 126 | 644.00 | 5,381 | 52 | 12,467 |
| Humboldt | 40 | 444.47 | 569 | | |
| Lander | 30 | 32.18 | 43 | | |
| Lyon | 1,044 | 620.05 | 425 | | |
| Mineral | 353 | 379.43 | 1,763 | | 46 |
| Nye | 14,493 | 14,625.45 | 5,909 | | |
| Pershing | 1,321 | 1,916.90 | 2,039 | | |
| Storey | 664 | 433.78 | 649 | | |
| Washoe | 147 | 190.80 | 75 | | |
| White Pine | 68 | 60.87 | 22 | | |
| | 69,337 | 57,954.24 | 86,180 | 2,045 | 12,513 |

## GOLD AND SILVER ORES.

Gold and silver ores were mined in 9 counties by 21 producers. The average of the output was $4.73 in gold and 3.77 ounces of silver to the ton, 0.08 per cent of copper, and 0.09 per cent of lead. Eight producers reported 37,088 tons from Storey County, mined in the Comstock district; the next largest quantity was mined in the Gold Circle district, Elko County. At Eureka the old slag dump of the Richmond-Eureka smelter produced considerable speiss, which is included in this report and helps to bring the total of Eureka County to third place in the output of gold and silver ores. This old slag from Eureka County also contained considerable copper and lead.

*Content of dry gold and silver ore sold or treated in Nevada in 1922.*

| County. | Ore. | Gold. | Silver. | Copper. | Lead. |
|---|---|---|---|---|---|
| | *Short tons.* | *Fine ounces.* | *Fine ounces.* | *Pounds.* | *Pounds.* |
| Churchill | 1 | 2.82 | 97 | | |
| Elko | 4,330 | 1,975.46 | 27,237 | | |
| Esmeralda | 76 | 179.50 | 4,945 | | |
| Eureka | 2,524 | 499.46 | 8,043 | 66,828 | 81,39 |
| Lyon | 7 | 7.51 | 139 | | |
| Mineral | 162 | 326.81 | 10,457 | | |
| Nye | 4 | 30.68 | 451 | | |
| Storey | 37,088 | 6,953.92 | 109,384 | | |
| White Pine | 311 | 213.00 | 6,951 | 1,171 | 1,05 |
| | 44,503 | 10,189.16 | 167,704 | 67,999 | 82,44 |

## SILVER ORE.

The output of siliceous silver ore was mined by 130 producers and averaged $1.97 in gold and 9.97 ounces of silver to the ton and 0.05 per cent of lead. The Tonopah district, in Nye County, was the largest producer of silver ore and was credited with 472,865 tons, produced from 16 properties.

*Content of dry silver ore sold or treated in Nevada in 1922.*

| County. | Ore. | Gold. | Silver. | Copper. | Lead. |
|---|---|---|---|---|---|
| | *Short tons.* | *Fine ounces.* | *Fine ounces.* | *Pounds.* | *Pounds.* |
| Churchill | 2,264 | 37.61 | 40,811 | ..... | ..... |
| Clark | 84 | 18.44 | 3,393 | 52 | 11 |
| Elko | 65 | 8.89 | 3,338 | 34 | 299 |
| Esmeralda | 21,111 | 2,519.70 | 612,191 | ..... | ..... |
| Eureka | 36 | .37 | 4,058 | 593 | 2,368 |
| Humboldt | 205 | 59.35 | 17,186 | 507 | 5,008 |
| Lander | 1,259 | 110.90 | 12,777 | 6,384 | 51,886 |
| Lincoln | 20,431 | 1,548.43 | 209,353 | 63,896 | 751,037 |
| Lyon | 1,790 | 94.11 | 4,710 | ..... | ..... |
| Mineral | 10,853 | 234.91 | 84,709 | 338 | 2,308 |
| Nye | 480,443 | 57,136.28 | 5,499,495 | 1,788 | 9,023 |
| Pershing | 117,886 | 3,500.98 | 823,645 | 1,046 | 2,903 |
| Storey | 101,000 | 7,047.83 | 219,611 | ..... | ..... |
| Washoe | 14 | 4.16 | 1,150 | 32 | ..... |
| White Pine | 602 | 41.00 | 19,546 | 1,324 | 2,700 |
| | 758,043 | 72,362.96 | 7,555,973 | 75,994 | 827,543 |

## COPPER ORE.

There were nine producers of copper ore in 1922. The ore averaged 14 cents in gold and 0.02 ounce of silver to the ton and 1.80 per cent of copper and was valued at $5.03 a ton. The Nevada Consolidated Copper Co., in the Robinson district, White Pine County, where the largest output was mined, resumed operations in April and was producing copper bullion at a fair rate in May and June, but the output was small thereafter, as the mill was burned in July.

*Content of copper ore sold or treated in Nevada in 1922.*

| County. | Ore. | Gold. | Silver. | Copper. | Lead. |
|---|---|---|---|---|---|
| | *Short tons.* | *Fine ounces.* | *Fine ounces.* | *Pounds.* | *Pounds.* |
| Elko | 99 | 2.34 | 625 | 27,700 | ..... |
| Eureka | 3 | ..... | 585 | 316 | ..... |
| Lincoln | 11 | ..... | 280 | 622 | 350 |
| White Pine | 629,295 | 4,398.29 | 15,637 | 22,611,404 | 74 |
| | 629,408 | 4,400.63 | 17,127 | 22,640,042 | 424 |

## LEAD ORE AND COPPER-LEAD ORE.

Lead ore was produced in Nevada at 88 mines in 1922, the same number as reported in 1921. The average content of the ore was $1.56 in gold and 17.70 ounces of silver to the ton, 0.42 per cent of copper, and 7.94 per cent of lead, and the ore was valued at $29.13 a ton. Nearly half of the lead ore was mined in Lincoln County, in the Pioche and surrounding districts. Washoe and Lander counties produced the next largest outputs.

The output of copper-lead ore was reported by three producers. The average content was 38 cents in gold and 21.11 ounces of silver to the ton, 5.53 per cent of copper, and 19.54 per cent of lead, and the average value was $57.93 a ton.

*Content of lead ore sold or treated in Nevada in 1922.*

| County. | Ore. | Gold. | Silver. | Copper. | Lead. |
|---|---|---|---|---|---|
| | *Short tons.* | *Fine ounces.* | *Fine ounces.* | *Pounds.* | *Pounds.* |
| Churchill | 1 | 0.04 | 28 | 13 | 545 |
| Clark | 541 | 897.75 | 3,752 | 12,847 | 217,849 |
| Elko | 1,699 | 7.77 | 41,175 | 3,429 | 768,828 |
| Esmeralda | 77 | 21.75 | 2,826 | 255 | 42,201 |
| Eureka | 1,752 | 752.35 | 31,795 | 1,892 | 496,202 |
| Humboldt | 44 | 2.56 | 833 | 218 | 21,355 |
| Lander | 5,034 | 38.72 | 72,290 | 4,598 | 68,001 |
| Lincoln | 18,085 | 993.09 | 206,266 | 252,568 | 2,827,646 |
| Mineral | 96 | 20.88 | 13,947 | 165 | 38,861 |
| Nye | 1,182 | 60.12 | 46,058 | 761 | 130,086 |
| Pershing | 283 | 32.72 | 10,512 | 5,680 | 93,898 |
| Washoe | 8,487 | 27.15 | 225,812 | 40,428 | 867,351 |
| White Pine | 2,181 | 124.95 | 43,296 | 8,314 | 693,824 |
| | 39,462 | 2,979.85 | 698,590 | 331,168 | 6,266,647 |

*Content of copper-lead ore sold or treated in Nevada in 1922.*

| County. | Ore. | Gold. | Silver. | Copper. | Lead. |
|---|---|---|---|---|---|
| | *Short tons.* | *Fine ounces.* | *Fine ounces.* | *Pounds.* | *Pounds.* |
| Lincoln | 4 | ..... | 210 | 220 | 780 |
| White Pine | 98 | 1.90 | 1,943 | 11,063 | 39,089 |
| | 102 | 1.90 | 2,153 | 11,283 | 39,869 |

## ZINC ORE AND LEAD-ZINC ORE.

The output of zinc ore was reported by three producers in the Yellow Pine district, Clark County, and the Robinson district, White Pine County.

Lead-zinc ore was produced from seven mines which operated in the Yellow Pine district, Clark County; the Battle Mountain district, Lander County; and the Bell district, Mineral County. The ore contained an average of 3.75 ounces of silver to the ton, 0.01 per cent of copper, 4.64 per cent of lead, and 4.20 per cent of zinc and was valued at $13.69 a ton. Most of the lead-zinc ore came from the Simon mine, in Mineral County.

*Content of zinc ore sold or treated in Nevada in 1922.*

| County. | Ore. | Lead. | Zinc. |
|---|---|---|---|
| | *Short tons.* | *Pounds.* | *Pounds.* |
| Clark | 208 | 2,400 | 176,80 |
| White Pine | 950 | ..... | 484,66 |
| | 1,158 | 2,400 | 661,46 |

*Content of lead-zinc ore sold or treated in Nevada in 1922.*

| County. | Ore. | Gold. | Silver. | Copper. | Lead. | Zinc. |
|---|---|---|---|---|---|---|
| | *Short tons.* | *Fine ounces.* | *Fine ounces.* | *Pounds.* | *Pounds.* | *Pounds.* |
| Clark | 1,412 | ..... | 4,115 | ..... | 140,240 | 714,374 |
| Lander | 37 | ..... | ..... | ..... | 2,220 | 18,870 |
| Mineral | 21,814 | 19.85 | 83,035 | 4,560 | 2,014,883 | 1,224,000 |
| | 23,263 | 19.85 | 87,150 | 4,560 | 2,157,343 | 1,957,244 |

## METALLURGIC INDUSTRY.

Fifty-six milling plants were reported in operation in Nevada in 1922. Of these plants 20 used the amalgamation process, 7 concentration (5 of which had flotation units), 26 cyanidation, 1 amalgamation, concentration, and cyanidation, 1 concentration and cyanidation, and 1 amalgamation and concentration.

About 522 pounds of mercury was purchased for use in amalgamation, and 1,831,592 pounds of sodium cyanide was used.

*Gold and silver produced from Nevada mills in 1922.*

| County. | Ore (short tons). | Bullion (fine ounces) recovered from ore by— | | | | Total value. |
|---|---|---|---|---|---|---|
| | | Amalgamation. | | Cyanidation. | | |
| | | Gold. | Silver. | Gold. | Silver. | |
| Churchill | 2,234 | 2.77 | 1 | ..... | 37,532 | $37,590 |
| Clark | 1,137 | 401.80 | 2,541 | 361.01 | 167 | 18,477 |
| Douglas | 18 | [a]26.26 | [a]12 | ..... | ..... | 555 |
| Elko | 46,958 | 171.23 | 131 | 25,796.18 | 88,030 | 624,955 |
| Esmeralda | 27,515 | 431.28 | 364 | [b]15,323.71 | [b]622,511 | 948,560 |
| Humboldt | 15 | 14.68 | 11 | ..... | ..... | 315 |
| Lander | 30 | 32.18 | 43 | ..... | ..... | 708 |
| Lincoln | 800 | ..... | ..... | 7.27 | 8,500 | 8,650 |
| Lyon | [c]1,099 | 407.05 | 281 | [d]294.89 | [d]4,970 | 19,761 |
| Mineral | 11,127 | 66.28 | 33 | [e]453.32 | 77,645 | 88,419 |
| Nye | 430,177 | [f]9,995.25 | [f]5,448 | [g]61,734.79 | [g]5,487,218 | 6,975,458 |
| Pershing | 117,879 | 1,731.12 | 1,013 | [h]3,602.77 | [h]806,675 | 917,949 |
| Storey | [i]137,389 | 983.88 | 869 | [j]13,059.15 | [j]314,649 | 605,813 |
| Washoe | 151 | 186.66 | 72 | .63 | 108 | 4,052 |
| White Pine | 68 | 58.65 | 14 | 2.22 | 8 | 1,280 |
| | 776,597 | 14,509.09 | 10,833 | 120,635.94 | 7,448,013 | 10,252,542 |

[a] Includes bullion from 17 tons of old tailings.
[b] Includes bullion from 800 tons of old tailings.
[c] Also yielded 7 tons of concentrates.
[d] Includes bullion from 1,740 tons of old tailings.
[e] Includes bullion from 25 tons of old tailings.
[f] Includes bullion from 200 tons of old tailings.
[g] Includes bullion from 62,956 tons of old tailings.
[h] Includes bullion from 290 tons of sweeps.
[i] Also yielded 56 tons of concentrates.
[j] Includes bullion from 1,275 tons of old tailings.

The output of milling ores was 1,334,963 tons, of which 776,597 tons was treated by amalgamation or cyanidation and 558,366 tons by concentration, followed by smelting. The 765,722 tons of ore and 67,303 tons of tailings and sweeps treated by cyanidation contained an average per ton of $2.99 in gold and 8.94 ounces of silver. The ores amalgamated (10,875 tons) yielded bullion averaging $27.58 in gold and 1 ounce of silver per ton of ore treated. About 36 per cent of the total ore was of concentrating grade and produced concentrate which was valued at $38.39 a ton. The output by counties and the average assay of the product follow:

*Mine production of gold, silver, copper, lead, and zinc from Nevada concentrates in 1922.*

**By counties.**

| County. | Ore to concentrating mills. | Concentrates. | Gold. | Silver. | Copper. | Lead. | Recoverable zinc. | Total value of concentrates. |
|---|---|---|---|---|---|---|---|---|
| | *Short tons.* | *Short tons.* | *Fine ounces.* | *Fine ounces.* | *Pounds.* | *Pounds.* | *Pounds.* | |
| Clark | 1,272 | 1,027 | | 4,115 | | 106,772 | 653,140 | $47,217 |
| Esmeralda | 10 | 1 | 2.63 | 977 | 33 | 881 | | 1,083 |
| Lander | 4,812 | 107 | 2.81 | 32,083 | 2,266 | 17,763 | | 33,424 |
| Lyon | | 7 | 19.17 | 2 | | | | 398 |
| Mineral | 21,814 | 3,650 | 21.31 | 83,069 | 4,563 | 2,015,495 | 1,224,000 | 264,745 |
| Nye | 2,580 | 144 | 30.57 | 24,922 | 1,890 | 44,522 | | 28,258 |
| Pershing | 961 | 113 | 4.16 | 11,723 | 443 | 418 | | 11,892 |
| Storey | | 56 | 102.06 | 8,700 | | | | 10,810 |
| Washoe | 8,394 | 1,165 | 16.87 | 217,840 | 40,089 | 843,913 | | 270,016 |
| White Pine | 518,523 | 48,084 | 4,276.05 | 14,681 | 9,745,733 | | | 1,418,749 |
| | 558,366 | 54,354 | 4,475.63 | 398,112 | 9,795,017 | 3,029,764 | 1,877,140 | 2,086,592 |

**By kinds of concentrates.**

| | | | | | | | | |
|---|---|---|---|---|---|---|---|---|
| Dry and siliceous | 261 | 155.03 | | 31,750 | 2,231 | 9,272 | | $35,765 |
| Copper | 48,084 | 4,276.05 | | 14,681 | 9,745,733 | | | 1,418,749 |
| Lead | 3,246 | 44.55 | | 333,681 | 47,053 | 2,908,292 | | 500,910 |
| Zinc | 2,763 | | | 18,000 | | 112,200 | 1,877,140 | 131,168 |

**Average content.**

| Kind of concentrates. | Concentrates. | Gold. | Silver. | Copper. | Lead. | Recoverable zinc. | Total value. |
|---|---|---|---|---|---|---|---|
| | *Short tons.* | *Fine ounces per ton.* | *Fine ounces per ton.* | *Per cent.* | *Per cent.* | *Per cent.* | |
| Dry and siliceous | 261 | 0.59 | 121.65 | 0.43 | 1.78 | | $137.03 |
| Copper | 48,084 | .09 | .31 | 10.13 | | | 29.51 |
| Lead | 3,246 | .01 | 102.80 | .72 | 44.80 | | 154.32 |
| Zinc | 2,763 | | 6.51 | | 2.03 | 33.97 | 47.47 |
| | 54,354 | .08 | 7.32 | 9.01 | 2.79 | 1.73 | 38.39 |

The oxidized lead ore, largely carbonates, of smelting grade increased from 16,585 tons in 1921 to 17,707 tons in 1922 and averaged $2.49 in gold, 16.92 ounces of silver, 14.55 pounds of copper, 199.34 pounds of lead, and $32.34 in total value to the ton. The sulphide lead ores of smelting grade averaged $1.95 in gold, 28.26 ounces of silver, 3.85 pounds of copper, 298.44 pounds of lead, and $47.14 in total value to the ton. The production of copper-lead ores decreased from 1,689 tons to 102 tons, all of which was oxidized or carbonate ore shipped directly to smelters and averaged $0.38 in gold, 21.11 ounces of silver, 110.62 pounds of copper, 390.87 pounds of lead, and $57.93 in total value to the ton. Of the lead-zinc ore produced (23,263 tons) only 177 tons was first-class shipping ore. All the zinc ore produced was oxidized or carbonate ore shipped directly to the smelter.

*Mine production of gold, silver, copper, lead, and zinc from Nevada crude ore shipped to smelters in 1922.*

**By counties.**

| County. | Ore. | Gold. | Silver. | Copper. | Lead. | Recoverable zinc. | Total value. |
|---|---|---|---|---|---|---|---|
| | *Short tons.* | *Fine ounces.* | *Fine ounces.* | *Pounds.* | *Pounds.* | *Pounds.* | |
| Churchill | 35 | 103.61 | 3,438 | 13 | 545 | ..... | $5,612 |
| Clark | 894 | 905.42 | 4,859 | 12,899 | 253,728 | 238,034 | 52,840 |
| Elko | 1,892 | 145.15 | 46,514 | 31,163 | 769,127 | ..... | 96,023 |
| Esmeralda | 237 | 607.33 | 2,646 | 2,215 | 41,320 | ..... | 17,772 |
| Eureka | 1,940 | 1,407.42 | 42,000 | 3,227 | 512,579 | ..... | 99,722 |
| Humboldt | 274 | 491.70 | 18,577 | 725 | 26,363 | ..... | 30,289 |
| Lander | 1,518 | 146.81 | 52,984 | 8,716 | 104,344 | 18,870 | 64,010 |
| Lincoln | 18,376 | 538.81 | 209,928 | 276,102 | 2,063,812 | ..... | 371,850 |
| Lyon | 2 | .56 | 21 | ..... | ..... | ..... | 33 |
| Mineral | 304 | 440.97 | 33,164 | 500 | 40,603 | ..... | 44,580 |
| Nye | 209 | 91.92 | 34,325 | 659 | 94,587 | ..... | 41,516 |
| Pershing | 333 | 109.88 | 15,007 | 6,283 | 96,383 | ..... | 23,427 |
| Storey | 88 | 290.43 | 5,426 | ..... | ..... | ..... | 11,430 |
| Washoe | 103 | 17.95 | 9,017 | 371 | 23,438 | ..... | 10,727 |
| White Pine | 114,914 | 503.09 | 72,692 | 12,700,353 | 736,737 | 484,666 | 1,865,786 |
| | 141,119 | 5,801.05 | 550,598 | 13,043,226 | 4,763,566 | 741,570 | 2,735,617 |

**By kinds of ore.**

| | | | | | | | |
|---|---|---|---|---|---|---|---|
| Dry and siliceous | 7,970 | 3,246.09 | 158,223 | 55,267 | 224,257 | ..... | $245,121 |
| Copper | 110,885 | 124.58 | 2,446 | 12,707,119 | 424 | ..... | 1,720,505 |
| Lead | 20,827 | 2,428.48 | 387,776 | 269,557 | 4,460,928 | ..... | 719,718 |
| Zinc | 1,158 | ..... | ..... | ..... | 2,400 | 661,466 | 37,835 |
| Copper-lead | 102 | 1.90 | 2,153 | 11,283 | 39,869 | ..... | 5,909 |
| Lead-zinc | 177 | ..... | ..... | ..... | 35,688 | 80,104 | 6,529 |

**Average content.**

| Kind of ore. | Ore. | Gold. | Silver. | Copper. | Lead. | Recoverable zinc. | Total value. |
|---|---|---|---|---|---|---|---|
| | *Short tons.* | *Fine ounces per ton.* | *Fine ounces per ton.* | *Per cent.* | *Per cent.* | *Per cent.* | |
| Dry and siliceous | 7,970 | 0.41 | 19.85 | 0.35 | 1.41 | ..... | $30.76 |
| Copper: | | | | | | | |
| Oxidized | 8,299 | .01 | .19 | 4.00 | ..... | ..... | 11.19 |
| Sulphide | 102,586 | ..... | .01 | 5.87 | ..... | ..... | 15.87 |
| Lead: | | | | | | | |
| Oxidized | 17,707 | .12 | 16.92 | .73 | 9.97 | ..... | 32.34 |
| Sulphide | 3,120 | .09 | 28.26 | .19 | 14.92 | ..... | 47.14 |
| Zinc: | | | | | | | |
| Oxidized | 1,158 | ..... | ..... | ..... | .10 | 28.56 | 32.67 |
| Copper-lead: | | | | | | | |
| Oxidized | 102 | .02 | 21.11 | 5.53 | 19.54 | ..... | 57.93 |
| Lead-zinc: | | | | | | | |
| Oxidized | 177 | ..... | ..... | ..... | 10.08 | 22.63 | 36.89 |
| | 141,119 | .04 | 3.90 | 4.62 | 1.69 | .26 | 19.39 |

## GOLD.

Nye County had the largest output of gold in 1922, and Elko, Esmeralda, and Storey counties followed. Ore was treated by amalgamation in 14 counties and by cyanidation in 12 counties. By these two methods of treatment $2,793,696 in gold was produced from 776,597 tons of ore and 67,303 tons of old tailings and sweeps. Placer gold was produced in greatest quantity in Lyon, Nye, and Lander counties, and the value of the total placer gold was $239,842, as against $363,142 in 1921. A large part of the placer gold in 1922 was obtained by dredging operations at Gold Canyon, in Lyon County,

and by hydraulic work in the Round Mountain district, Nye County, and the Battle Mountain district, Lander County.

Eight producers supplied nearly 61 per cent of the total gold in 1922. Their properties, which yielded more than 5,000 ounces each, were the Elkoro mines, at Jarbidge; West End, Tonopah Extension, Tonopah Belmont, and Tonopah Mining, at Tonopah; Goldfield Consolidated, at Goldfield; Round Mountain Mining Co., at Round Mountain; and Gold Canyon Dredging Co., in Lyon County.

## SILVER.

The mine production of silver increased 1,535,805 ounces, as compared with 1921. Milling plants in Nye County were credited with 5,517,588 ounces, most of which (5,487,218 ounces) was recovered by cyanidation from ores treated principally in the Tonopah district. In the Rochester district, Pershing County, 797,559 ounces of silver was recovered by cyanidation. Concentrates from milling plants yielded 398,112 ounces of silver, against 208,363 ounces in 1921. Siliceous concentrates contained 31,750 ounces, against 18,062 ounces in 1921; and copper concentrates 14,681 ounces, against 12,582 ounces in 1921. Lead concentrates contained 333,681 ounces of silver, or an average per ton of 102.80 ounces, against 162,851 ounces, or an average of 154.80 ounces, in 1921.

More than 68 per cent of the total silver was produced from the Tonopah Extension, West End, Tonopah Belmont, and Tonopah Mining, all at Tonopah; Tonopah Divide, in Esmeralda County; and the Rochester Silver, in Pershing County.

## COPPER.

The mine production of copper in Nevada in 1922 increased $1,708,935 in value. The mine of the Nevada Consolidated Co., at Ely, in White Pine County, which resumed operations after being closed a year, was the largest producer. Other large producers were the Boston-Ely mine, in White Pine County; and the Bristol Silver property, near Pioche, in Lincoln County. The Mason Valley copper smelter, at Thompson, remained idle.

## LEAD.

The mine production of lead in Nevada in 1922 increased more than 30 per cent. Lincoln County continued to have the largest output of lead, followed by Mineral County. More than 32 per cent of the lead was derived from concentrates of milling ore, and nearly 51 per cent from crude ore shipped directly to smelters. Lead concentrates (carbonates and sulphides) shipped to smelters contained 2,908,292 pounds of lead, against 739,487 pounds in 1921, and averaged 44.80 per cent of lead, against 35.15 per cent in 1921. The total crude ore of shipping grade contained 4,763,566 pounds of lead, against 6,136,809 pounds in 1921. Oxidized lead ore shipped to smelters contained 3,529,779 pounds of lead, and sulphide ore 931,149 pounds, against 4,404,370 pounds and 293,950 pounds, respectively, in 1921. Copper-lead ore of shipping grade, all of which was oxidized, produced 39,869 pounds of lead. The oxidized lead-zinc ore of smelting grade produced 35,688 pounds of lead.

More than 63 per cent of the lead came from four mines. The leading producer was the Simon Silver-Lead mine, in the Bell district, Mineral County, followed by the Prince Consolidated, Lincoln County; the Bristol Silver, near Pioche; and the Leadville, Washoe County.

## ZINC.

The output of zinc from zinc and lead-zinc ores in Nevada in 1922 was 2,618,710 pounds. Mineral County made the largest part of the output, from the Bell district, and was followed in order by the Yellow Pine district, Clark County; Robinson district, White Pine County; and Battle Mountain district, Lander County.

## MINING INDUSTRY.

The decrease in operating costs, lower freight rates, and advance in prices of copper, lead, and zinc were all important to the mining industry in 1922. Ore developed in several mining districts warranted the construction of several milling plants, notably the 2,500-ton cyanidation mill of the United Comstock Co. This plant was built on American Flat and started to crush ore September 23. In Lander County the Betty O'Neal mill, south of Battle Mountain, the Cortez mill, at Cortez, and the Hilltop mill, in the Hilltop district, were under construction. Mills at Tonopah were given increased capacity, and the Simon mill, in the Bell district, was enlarged. The Candelaria mill was completed and treated some ore late in the year.

Since the war the Nevada Mine Operators' Association has advantageously contracted in advance with manufacturers for the quantity of cyanide necessary to supply all the gold and silver mills in Nevada. The contract for 1923 was made on the basis of 100 per cent sodium cyanide and is 500,000 pounds in excess of the supply of 2,500,000 pounds contracted for the mills in 1922. The manufactured product contains 48.5 per cent of sodium cyanide [3] and is made at Niagara Falls, Ontario, Canada.

Mineral County has contributed to the support of its mining industry by the investment of $150,000 in electric transmission lines. Bonds were issued for this amount, which was necessary to purchase a power line terminating at Hawthorne, but later 70 miles of new line was built to the town of Mina, east to the Simon mine, and south to Candelaria.[4]

Operations at Tonopah continued throughout 1922 with but one interruption when, in October, a strike for higher wages by underground employees caused a cessation of mining for three days before a compromise settlement was concluded. Economic conditions affecting operations were somewhat more favorable than in 1921. Average wage scales were slightly lower, as were the average unit costs of supplies, but in October wages were raised 50 cents a shift. The production increased as a result of the price of silver and steady operations. Reduced rates on ores from Nevada over the Southern Pacific Railroad to the Utah smelters took effect October 22 on all classes of ore valued at $20 a ton or less, which under old conditions could not be marketed.

[3] Nevada Min. Press, Jan. 5, 1923, p. 3.

[4] Idem, Dec. 29, 1922, p. 4.

# REVIEW BY COUNTIES.

## GENERAL FEATURES.

*Mine production of gold, silver, copper, lead, and zinc in Nevada in 1922, by counties.*

| County. | Gold. | | | | | Silver. | |
|---|---|---|---|---|---|---|---|
| | Placers. | | Deep mines. | | Total value. | Fine ounces. | Value. |
| | Fine ounces. | Value. | Fine ounces. | Value. | | | |
| Churchill | | | 106.38 | $2,199 | $2,199 | 40,971 | $40,971 |
| Clark | | | 1,668.21 | 34,485 | 34,485 | 11,682 | 11,682 |
| Douglas | 4.11 | $85 | 26.27 | 543 | 628 | 13 | 13 |
| Elko | 19.25 | 398 | 26,112.54 | 539,794 | 540,192 | 134,682 | 134,682 |
| Esmeralda | | | 16,364.97 | 338,294 | 338,294 | 626,498 | 626,498 |
| Eureka | 59.99 | 1,240 | 1,896.20 | 39,198 | 40,438 | 49,866 | 49,866 |
| Humboldt | 13.16 | 272 | 506.39 | 10,468 | 10,740 | 18,593 | 18,593 |
| Lander | 2,887.74 | 59,695 | 181.80 | 3,758 | 63,453 | 85,539 | 85,539 |
| Lincoln | | | 2,541.53 | 52,538 | 52,538 | 416,109 | 416,109 |
| Lyon | 5,335.71 | 110,299 | 721.66 | 14,918 | 125,217 | 7,837 | 7,837 |
| Mineral | 2.18 | 45 | 981.86 | 20,297 | 20,342 | 193,919 | 193,919 |
| Nye | 3,040.18 | 62,846 | 71,852.54 | 1,485,324 | 1,548,170 | 5,553,563 | 5,553,563 |
| Pershing | 17.27 | 357 | 5,450.60 | 112,674 | 113,031 | 836,199 | 836,199 |
| Storey | | | 14,435.54 | 298,409 | 298,409 | 329,644 | 329,644 |
| Washoe | 3.34 | 69 | 222.09 | 4,591 | 4,660 | 227,038 | 227,038 |
| White Pine | 219.43 | 4,536 | 4,840.01 | 100,052 | 104,588 | 87,434 | 87,434 |
| | 11,602.36 | 239,842 | 147,908.59 | 3,057,542 | 3,297,384 | 8,619,587 | 8,619,587 |

| County. | Copper. | | Lead. | | Recoverable zinc. | | Total value. |
|---|---|---|---|---|---|---|---|
| | Pounds. | Value. | Pounds. | Value. | Pounds. | Value. | |
| Churchill | 13 | $2 | 545 | $30 | | | $43,202 |
| Clark | 12,899 | 1,741 | 360,500 | 19,827 | 891,174 | $50,797 | 118,532 |
| Douglas | | | | | | | 641 |
| Elko | 31,163 | 4,207 | 769,127 | 42,302 | | | 721,383 |
| Esmeralda | 2,248 | 303 | 42,201 | 2,321 | | | 967,416 |
| Eureka | 69,681 | 9,407 | 592,430 | 32,584 | | | 132,295 |
| Humboldt | 725 | 98 | 26,363 | 1,450 | | | 30,881 |
| Lander | 10,982 | 1,483 | 122,107 | 6,716 | 18,870 | 1,075 | 158,266 |
| Lincoln | 317,306 | 42,836 | 3,579,813 | 196,890 | | | 708,373 |
| Lyon | | | | | | | 133,054 |
| Mineral | 5,063 | 684 | 2,056,098 | 113,085 | 1,224,000 | 69,768 | 397,798 |
| Nye | 2,549 | 344 | 139,109 | 7,651 | | | 7,109,728 |
| Pershing | 6,726 | 908 | 96,801 | 5,324 | | | 955,462 |
| Storey | | | | | | | 628,053 |
| Washoe | 40,460 | 5,462 | 867,351 | 47,704 | | | 284,864 |
| White Pine | 22,633,276 | 3,055,492 | 736,737 | 40,521 | 484,666 | 27,626 | 3,315,661 |
| | 23,133,091 | 3,122,967 | 9,389,182 | 516,405 | 2,618,710 | 149,266 | 15,705,609 |

*Production from deep mines in Nevada in 1921 and 1922, by counties.*

| County. | Ore sold or treated, 1922 (short tons). | | Number of deep mines producing. | | Average value per ton.[a] | | Average value per ton in gold and silver.[a] | |
|---|---|---|---|---|---|---|---|---|
| | Total. | Increase or decrease. | 1921 | 1922 | 1921 | 1922 | 1921 | 1922 |
| Churchill | 2,269 | +2,199 | 9 | 8 | $89.49 | $19.04 | $64.44 | $19.03 |
| Clark | 3,303 | +1,832 | 15 | 18 | 72.65 | 35.89 | 58.85 | 13.98 |
| Douglas | 35 | +31 | 2 | 3 | 21.50 | 15.86 | 21.50 | 15.86 |
| Elko | 48,850 | −5,324 | 26 | 30 | 17.29 | 14.76 | 16.00 | 13.81 |
| Esmeralda | 28,562 | +2,656 | 26 | 31 | 26.14 | 33.87 | 26.01 | 33.78 |
| Eureka | 4,441 | −5,303 | 15 | 20 | 16.21 | 29.51 | 9.88 | 20.05 |
| Humboldt | 289 | −5 | 11 | 15 | 148.95 | 105.90 | 148.25 | 100.54 |
| Lander | 6,360 | +2,701 | 18 | 10 | 16.37 | 15.43 | 14.49 | 13.97 |
| Lincoln | 38,531 | +3,443 | 25 | 17 | 13.01 | 18.38 | 7.78 | 12.16 |
| Lyon | 2,841 | −6,091 | 23 | 12 | 5.27 | 7.11 | 5.27 | 7.11 |
| Mineral | 33,278 | +26,166 | 34 | 38 | 22.62 | 11.95 | 21.80 | 6.44 |
| Nye | 496,122 | +113,058 | 71 | 60 | 15.36 | 14.21 | 15.35 | 14.18 |
| Ormsby | | −4 | 1 | | 55.50 | | 45.75 | |
| Pershing | 119,490 | +27,903 | 39 | 30 | 10.24 | 7.99 | 10.20 | 7.94 |
| Storey | 138,752 | +74,151 | 17 | 15 | 9.11 | 4.53 | 9.11 | 4.53 |
| Washoe | 8,618 | +555 | 11 | 12 | 25.86 | 32.93 | 21.76 | 26.78 |
| White Pine | 633,505 | +231,170 | 27 | 26 | 3.71 | 5.23 | .36 | .30 |
| | 1,565,276 | +469,138 | 370 | 345 | 10.73 | 9.88 | 9.15 | 7.46 |

[a] Placer product excluded.

*Production from placer mines in Nevada in 1921 and 1922, by counties.*

| County. | 1921 | | | | | | 1922 | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | Mines. | | | Gold. | Silver (fine ounces). | Total value. | Mines. | | | Gold. | Silver (fine ounces). | Total value. |
| | Hydraulic. | Drift. | Dredge. | | | | Hydraulic. | Drift. | Dredge. | | | |
| Douglas | 1 | .... | .... | $48 | ..... | $48 | 1 | .... | .... | $85 | 1 | $86 |
| Elko | 6 | .... | .... | 1,951 | 36 | 1,987 | 3 | .... | .... | 398 | 7 | 405 |
| Esmeralda | 2 | .... | .... | 574 | 1 | 575 | ..... | ..... | ..... | ..... | ..... | ..... |
| Eureka | 1 | .... | .... | 414 | 2 | 416 | 1 | .... | .... | 1,240 | 4 | 1,244 |
| Humboldt | 1 | .... | .... | 498 | 4 | 502 | 2 | .... | .... | 272 | 5 | 277 |
| Lander | 10 | 2 | .... | 71,750 | 509 | 72,259 | 7 | 1 | .... | 59,695 | 429 | 60,124 |
| Lyon | ..... | .... | 1 | 133,020 | 3,523 | 136,543 | 1 | .... | 1 | 110,299 | 2,563 | 112,862 |
| Mineral | 2 | .... | .... | 136 | 5 | 141 | 1 | .... | .... | 45 | 8 | 53 |
| Nye | a 29 | 4 | .... | 154,463 | 3,874 | 158,337 | a 15 | 3 | .... | 62,846 | 1,650 | 64,496 |
| Pershing | 1 | .... | .... | 87 | 1 | 88 | ..... | 1 | .... | 357 | 3 | 360 |
| Washoe | ..... | ..... | ..... | ..... | ..... | ..... | 1 | .... | .... | 69 | 1 | 70 |
| White Pine | 1 | .... | .... | 201 | 1 | 202 | 4 | .... | .... | 4,536 | 39 | 4,575 |
| | 54 | 6 | 1 | 363,142 | 7,956 | 371,098 | 36 | 5 | 1 | 239,842 | 4,710 | 244,552 |

a Part of operations drifting and sluicing.

## CHURCHILL COUNTY.

*Broken Hills district.*—The Broken Hills property produced ore that was treated by cyanidation and yielded bullion containing principally silver. As the property has no mill, the ore was hauled to the plant of the Kansas City Consolidated Mines Co., in the Bruner section, Nye County, which was operated as a custom mill. A small lot of lead ore of smelting grade was mined and shipped from the Highway claim.

*Fairview district.*—A little silver ore was mined from the Dromedary Hump property, in which a little arsenical pyrite assaying $5 in gold and from 1 to 2 ounces of silver a ton is said to occur. A lessee at the Nevada Hills property made a shipment of material cleaned up from the old mill site.

*Wonder district.*—Clean-up material containing silver was also shipped during the dismantling of the cyanidation mill of the Nevada Wonder property.

## CLARK COUNTY.

*Mine production of gold, silver, copper, lead, and zinc in Clark County, Nev., in 1921 and 1922.*

| Year. | Number of producers. | Ore. | Gold. | Silver. | Copper. | Lead. | Recoverable zinc. | Total value. |
|---|---|---|---|---|---|---|---|---|
| | | *Short tons.* | | *Fine ounces.* | *Pounds.* | *Pounds.* | *Pounds.* | |
| 1921 | 15 | 1,471 | $74,476 | 12,094 | 31,247 | 284,217 | 69,397 | $106,861 |
| 1922 | 18 | 3,303 | 34,485 | 11,682 | 12,899 | 360,500 | 891,174 | 118,532 |
| Increase or decrease, 1922 | +3 | +1,832 | −39,991 | −412 | −18,348 | +76,283 | +821,777 | +11,671 |

*Searchlight district.*—Seven producers in the Searchlight district reported 1,441 tons of ore, all of which, with the exception of 304 tons of shipping grade, was milled at amalgamation and cyanidation plants, producing gold and silver. Most of the milling ore came from the Cyrus Noble, Riverview, Duplex, Sam Yet, and Fearless mines. A considerable part of the output of the Duplex mine was oxidized lead ore and was shipped directly to the smelter.

*Yellow Pine district.*—Of the 1,861 tons of ore produced in the Yellow Pine district, the largest part, or 1,272 tons, was milled and separated into lead concentrate and zinc concentrate, which were shipped to the smelter with 589 tons of first-class ore, principally lead-zinc ore with some lead ore. The Yellowpine Mining Co. was the most active operator in the district and shipped most of the ore. The company resumed operations in July after a long idleness, but shipments were not made until late in the year. Zinc concentrate was shipped to eastern zinc plants, and the lead ore and concentrates to smelters near Salt Lake. Smaller lots of lead-zinc ore were produced from the Anchor, Milford & Addison, Ingomar, and Tiffin mines. The Root Zinc mine produced lead ore, and shipments of this product were also made to the smelters from the Anchor, May Kirby, Potosi, and Christmas mines.

## DOUGLAS COUNTY.

A small lot of gold ore was hauled 20 miles from the Side Track property, in the Pine Nut district, and treated in a Gibson amalgamation mill owned by Adams & Taylor at Yerington.

## ELKO COUNTY.

*Mine production of gold, silver, copper, and lead in Elko County, Nev., in 1921 and 1922.*

| Year. | Number of producers. | Ore. | Gold.[a] | Silver.[a] | Copper. | Lead. | Total value. |
|---|---|---|---|---|---|---|---|
| | | *Short tons.* | | *Fine ounces.* | *Pounds.* | *Pounds.* | |
| 1921 | 32 | 54,174 | $604,305 | 264,439 | 10,147 | 1,525,192 | $938,687 |
| 1922 | 33 | 48,850 | 540,192 | 134,682 | 31,163 | 769,127 | 721,383 |
| Increase or decrease, 1922 | +1 | −5,324 | −64,113 | −129,757 | +21,016 | −756,065 | −217,304 |

[a] Includes placer production.

*Contact district.*—The Delano and Blue Bird properties produced 71 tons of copper ore containing considerable silver, which averaged $50.46 a ton. The ore was mined by lessees and was hauled 35 miles to Rogerson, Idaho, on the Oregon Short Line Railroad. A branch railroad line may be completed from Rogerson to Contact before the end of another year.

*Delno district.*—From the Net No. 2 property a considerable output of lead ore containing silver was hauled 35 miles south to Montello, on the Southern Pacific Railroad. It is reported that the company operating the property has developed 15,000 tons of oxidized ore averaging about 18 ounces of silver to the ton and 20 per cent of lead.

*Gold Circle district (Midas).*—Eight operators in the Gold Circle district reported an output containing $46,895 in gold and 28,748 ounces of silver, most of which was obtained from ore and mill cleanings from the Elko Prince property. Bullion from the Sleeping Beauty, Panhandle, and Vidette ores, which were treated at a custom mill in the district, made up the remainder of the output. The Elko Prince Mining Co. permanently discontinued operations about April 15, owing to the burning of its mill, and was in process of liquidation during 1922, as the remaining ore reserve did not warrant rebuilding the plant.[5]

*Jarbidge district.*—The ore of the Jarbidge district occurs in replacement deposits and fault fissures in the rhyolite, and the district is fully described in Bulletin 741, recently issued by the Geological Survey. The principal mine operations were carried on throughout the year in the Long Hike, Starlight, and O. K. mines of the Elkoro Mines Co.,[6] which was active throughout the year. Mining was also done by lessees on the Legitimate and Flaxie groups. The work developed about 25,000 tons of gold ore, valued at $12 a ton, largely in the O. K. mine. The report of the Yukon Gold Co. gives the production of the Elkoro property as follows:

> A total of 42,421 tons of ore was milled, which yielded $552,905. The average value of the ore treated was $13 a ton, and the total cost of mining and milling, excluding depreciation and development, was $253,504, or $6 a ton. There was charged off in connection with current development $34,023, leaving a net profit of $265,379.

*Lone Mountain district.*—A little lead ore from the Rip Van Winkle mine was shipped to the smelter at Midvale, Utah.

*Rock Creek district.*—The Ruby King claim, in the Independence Range, 70 miles from Tuscarora, produced a little bullion and silver recovered from ore mined by lessees. The property has two vertical shafts, each 300 feet deep.

*Spruce Mountain district.*—Six producers in the Spruce Mountain district reported the output of 1,197 tons of ore, all of which was of shipping grade, containing $128 in gold, 26,791 ounces of silver, 3,082 pounds of copper, and 474,421 pounds of lead, valued in all at $53,428, or $44.63 a ton. Some of the ore shipped from the Spruce Monarch mine, which was the largest producer, averaged 24 ounces of silver to the ton, 22 per cent of lead, 22 per cent of iron, 1.7 per cent of zinc, and 12 per cent of speiss. Regular shipments of silver ore and lead ore were made from the Bullshead property, which is said to have some 10,000 tons of ore in reserve, averaging 10 ounces of silver to the ton and 3 per cent of lead. Other mines producing lead ore were the Ada H., Black Forest, Index, and Valley.

*Tecoma district.*—Ore from the Jackson group averaged 8.8 ounces of silver to the ton, 20 per cent of lead, 2 per cent of zinc, 1 per cent of sulphur, and 18 per cent of iron. About 2,000 tons of 10 per cent lead ore, carrying 3 ounces of silver to the ton, is said to be in reserve.

*Tuscarora district.*—A small quantity of silver bullion and a little silver ore were produced from the Nevada claim, at Tuscarora.

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[5] Personal communication, Mar. 22, 1923.
[6] Yukon Gold Co. Ann. Rept. for year ending Dec. 31, 1922.

## ESMERALDA COUNTY.

*Mine production of gold, silver, copper, and lead in Esmeralda County, Nev., in 1921 and 1922.*

| Year. | Number of producers. | Ore. | Gold. | Silver. | Copper. | Lead. | Total value. |
|---|---|---|---|---|---|---|---|
| | | *Short tons.* | | *Fine ounces.* | *Pounds.* | *Pounds.* | |
| 1921 | 28 | 25,906 | $228,552 | 445,826 | 4,244 | 61,024 | $677,671 |
| 1922 | 31 | 28,562 | 338,294 | 626,498 | 2,248 | 42,201 | 967,416 |
| Increase or decrease, 1922 | +3 | +2,656 | +109,742 | +180,672 | −1,996 | −18,823 | +289,745 |

*Desert district.*—The Carrie Silver Lead Mines Co. produced milling ore and smelting ore containing silver and lead from a prospect in the Desert district.

*Goldfield district.*—The output of ore in the Goldfield district in 1922 had an average value of $48.06 a ton, against $31.80 in 1921. Of the 5,619 tons of ore produced, 5,451 tons was of milling grade and 168 tons was shipped to the smelter. The total bullion recovered contained $264,041 in gold and 5,755 ounces of silver, which, added to the copper content of several small lots of ore, gave the output of the district a total value of $270,065. Lessees reported mining ore from several parts of Goldfield Consolidated territory, and smaller quantities were produced from the Lawrence, Great Bend, and Jumbo properties. The Silver Pick Mining Co. operated a lease on a portion of the Red Top mine, which produced gold ore. The Florence mine was worked principally by lessees, who also shipped rich gold ore. The Goldfield Deep Mines Co., which acquired the Florence mine, has a shaft 1,400 feet deep and expects to sink to the 2,400-foot point.

*Mine production of gold, silver, copper, and lead in Goldfield district, Nevada, 1921–22.*

| Year. | Ore. | Gold. | Silver. | Copper. | Lead. | Total value. |
|---|---|---|---|---|---|---|
| | *Short tons.* | | *Fine ounces.* | *Pounds.* | *Pounds.* | |
| 1921 | 4,668 | $146,782 | 1,761 | 3,689 | ..... | $149,019 |
| 1922 | 5,619 | 264,041 | 5,755 | 1,993 | ..... | 270,065 |
| Increase or decrease, 1922 | +951 | +117,259 | +3,994 | −1,696 | ..... | +121,046 |
| Total 1904–1922 | ..... | 82,771,626 | 1,350,782 | 7,558,245 | 27,540 | 85,077,756 |

According to the annual report of the Goldfield Consolidated Mines Co.,[7] 4,782 tons of ore was produced. On different parts of the property 56 leases were issued, and $28,365 was received in royalty. Experimental work on mill tailing was continued. It indicated that some profit might be expected from the treatment of the tailing, but the margin remains too small under present costs of labor and supplies.

*Gold Mountain (Divide) district.*—Ten producers in the Gold Mountain district took advantage of the high price of silver and shipped

[7] Goldfield Consolidated Mines Co. Ann. Rept. for year ending Dec. 31, 1922.

20,132 tons of silver ore to the cyanide mills at Tonopah. The total output contained $52,392 in gold and 595,205 ounces of silver, valued together at $647,597, or $32.17 a ton. Most of the district ore was mined from the Tonopah Divide property. The mine is opened by a vertical shaft 1,400 feet deep. The next largest producer was the Gold Zone mine, followed by the Hasbrouck, Belcher, Divide Extension, New Tonopah Divide, and Belcher Extension properties.

During 1922 the working shaft of the Tonopah Divide mine was deepened 216 feet, making the total depth 1,445 feet. The ore mined and shipped to mills at Tonopah amounted to 18,885 tons and averaged $32.60 a ton in gold and silver. At the mine 849 tons of second-class ore averaging $11.18 a ton was added to the stock pile of mill ore.

*Hornsilver district.*—A small lot of silver ore was shipped from the Silver Dollar claim.

*Klondyke district.*—Bullion containing gold and silver was reported from the Golden State Divide property, the ore of which was treated in a custom mill at Tonopah. A small lot of silver-lead ore, which was hauled 3 miles to Klondyke, on the Tonopah & Goldfield Railroad, was also shipped to a smelter near Salt Lake.

*Lida district (Tule Canyon).*—From the Reward group a lessee shipped 20 tons of ore, containing an average of 10 ounces of silver to the ton, 59 per cent of lead, 16 per cent of insoluble matter, 0.6 per cent of iron, 0.5 per cent of zinc, and 8 per cent of sulphur. The ore from this property is loaded at Blair Junction, on the Southern Pacific Railroad. Several small lots of ore were shipped from prospects.

*Red Mountain district.*—Considerable attention has been given to the discovery of silver ore at Argentite. Rich silver ore was mined by lessees from the Sanger Taylor group.

*Silver Peak district.*—A 10-stamp mill with concentrators was operated on ore previously mined from the Silver Peak property. Part of the ore was treated by amalgamation and concentration, and part was shipped to cyanidation plants at Tonopah. A large quantity of crude ore and old tailings from the same property was also treated by amalgamation and cyanidation by the Lucky Boy Divide Mining Co.

*West Divide district.*—Small lots of silver ore were mined from the Occident Divide and West Divide properties. This ore was shipped to cyanidation plants at Tonopah.

## EUREKA COUNTY.

*Mine production of gold, silver, copper, and lead in Eureka County, Nev., in 1921 and 1922.*

| Year. | Number of producers. | Ore. | Gold.[a] | Silver.[a] | Copper. | Lead. | Total value. |
|---|---|---|---|---|---|---|---|
| | | *Short tons.* | | *Fine ounces.* | *Pounds.* | *Pounds.* | |
| 1921 | 16 | 9,744 | $50,833 | 45,904 | 206,948 | 776,943 | $158,395 |
| 1922 | 21 | 4,441 | 40,438 | 49,866 | 69,681 | 592,430 | 132,295 |
| Increase or decrease, 1922 | +5 | −5,303 | −10,395 | +3,962 | −137,267 | −184,513 | −26,100 |

[a] Includes placer production.

*Cortez district.*—The Bullion Hill and Keystone properties, on the Eureka County side of the Cortez district, produced lead ore containing considerable silver and a little copper. The Bullion Hill property, which has a vertical shaft 250 feet deep, was worked by lessees.

*Eureka district.*—Fifteen producers in the Eureka district reported an output of 1,735 tons of ore of shipping grade, and two of the producers shipped 3,643 tons of arsenical speiss, of which only 2,501 tons is accounted for in this report. The total metallic content of the output credited to the district in 1922 was $39,174 in gold, 44,925 ounces of silver, 68,450 pounds of copper, and 501,980 pounds of lead, valued in all at $120,949, or $28.55 a ton. All the speiss came from the old slag dump of the Richmond-Eureka smelter and the Silver West slag dump. Most of the ore was taken from the Croesus mine, which produced silver-lead ore containing gold. Other producers were the Cyanide, Helen Mortimer, Holly, Uncle Sam, Jackson, Eureka Nevada, Bay State, Cedar Tree, and Bullwhacker properties.

The annual report of the company operating the Richmond-Eureka mine[8] contains the following paragraph:

> Shipment of speiss from the waste dump was suspended early in 1922 on account of the low price of arsenic and consequent lack of market. When the price improved toward the end of the year shipments were renewed at an increased rate. Altogether 3,585 tons of speiss was shipped in 1922, largely to the smelter at Midvale, near Salt Lake City.

*Mineral Hill district.*—The Union Mines, Mineral Hill, and Homestake properties produced lead ore and copper ore containing some silver, which was taken out in the course of development work.

### HUMBOLDT COUNTY.

*Black Rock district.*—The Abe Lincoln and Magnolia mining claims produced a little silver ore, which was shipped to the smelter.

*Gold Run district.*—The Dolomite claim, operated by the Northwest Divide Mining Co., produced silver ore. Shipments of lead ore containing silver were made from the Black Diamond and Last Chance groups.

*Iron Point district.*—The Silver Coin property, 3 miles west of Iron Point, a station on the Southern Pacific Railroad, has been worked in a small way since 1918 and has produced 483 tons of ore which contained principally silver. There are a number of shallow shafts, open cuts, and surface trenches on the claim. The largest is the Silver Coin shaft, 165 feet deep, sunk on an incline of about 23° from the surface. The ore produced was part oxidized and part sulphide, showing cerargyrite, argentite, tetrahedrite, cerusite, and a little malachite, azurite, and cinnabar.

*National district.*—Lessees operating property in the vicinity of the National mine shipped several small lots of rich gold ore.

*New Central district.*—First-class gold ore from the Golden Eagle mine was shipped for smelting.

*New Goldfields district.*—The Cotton Tail mine produced gold ore carrying silver.

*Paradise district.*—From the Ford claim lead ore carrying a little copper and silver was shipped to a smelter near Salt Lake City. The property is 12 miles north of Golconda.

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[8] United States Smelting, Refining & Mining Co. Seventeenth Ann. Rept., for year ending Dec. 31, 1922.

*Winnemucca Mountain district (Barrett Springs).*—Four deep mines in the Winnemucca Mountain district produced 82 tons of ore, and two placer operators reported some bullion from surface operations. The total output was valued at $6,072. The Bay Bee property produced both gold ore of shipping grade and a little bullion. The Dolcoath mine produced a little gold ore, which was treated by amalgamation.

## LANDER COUNTY.

*Battle Mountain district.*—Five producers of ore in the Battle Mountain district reported 1,291 tons, all of which, with the exception of 30 tons treated in an amalgamation mill, was of shipping grade. The total output of the district, including the bullion ($60,124) from eight placer producers, contained $62,010 in gold, 8,865 ounces of silver, 6,393 pounds of copper, 63,019 pounds of lead, and 18,870 pounds of recoverable zinc, valued in all at $76,279. The Irish Rose mine, operated by the Toulon Arsenic Co., was the largest producer of ore valued principally for its arsenic. The ore was roasted, crude arsenic was recovered in the flues, and the residue or calcined product, containing gold, silver, copper, lead, zinc, and iron, was shipped to the smelters near Salt Lake. A little zinc ore, containing silver and lead, was shipped from the Lucky Strike claim to a zinc oxide plant near Salt Lake City. Lead ore was produced from the Buckingham claim, and gold bullion and silver ore were shipped from the Harriet and Little Giant properties.

*Bullion district.*—A little oxidized lead ore containing silver was shipped to the smelter from the Utah mine, 6 miles west of Lander.

*Cortez district.*—The Cortez district is on the boundary line between Lander and Eureka counties. Its main camp (Cortez) lies at an altitude of 6,280 feet, about 1 mile west of Mount Tenabo, a peak of the Cortez Range, and is 36 miles from Beowawe, the loading station on the Southern Pacific Railroad. In 1919 the Consolidated Cortez Silver Mines Co. took possession of all the mining property of the Cortez Mines (Ltd.) and the Wenban interests. Before and since these changes were made lessees operated in different parts of the property, confining their efforts to gouging out high-grade ore containing from 30 to 60 ounces of silver to the ton. Approximately $8,000,000, principally from silver, is said to have been produced from the Cortez properties, and some reports give totals ranging from $10,000,000 to $15,000,000. The higher figures may include the earlier shipments to Austin under the Wenban-Hearst control. Recent milling tests have demonstrated that gravity concentration and cyanidation will recover a high percentage of the metal contents of the ore. Construction of the mill was begun late in 1922, and it was expected that the plant would be completed in June, 1923. Although no report of the production was made to the Geological Survey, it is known that lessees were at work on the property and that shipments of silver ore were made to the smelter. The annual report of the company contains the following paragraphs by its geologist:[9]

> There are several types of ore deposits in the mine, all of which are of importance. They all consist of high-grade silver-lead ores and are differentiated by form and mode of occurrence rather than by their composition. They may be enumerated as

[9] Burgess, J. A., Consolidated Silver Mines Co. Ann. Rept. for year ending Dec. 31, 1922.

(1) ore bodies in limestone; (2) ore bodies on the contact between quartzite and limestone; (3) ore bodies in quartzite; (4) ore bodies in the porphyry dike.

The ore is primary. It was deposited from uprising solutions of siliceous character, and quartz almost invariably accompanies it. * * * In the limestone the quartz formed as a replacement of the limestone or of calcite veins. * * * The ore minerals are galena of moderate grain and high silver content; an undetermined dark mineral of metallic luster that accompanies the galena and carries high silver values; chalcopyrite, probably argentiferous; and sphalerite in small proportion. * * * The occasional occurrence of dark ruby silver shows the presence of antimony. * * * Of these minerals, galena is the most prominent and is found in all classes of ore. * * *

The solutions that deposited the ore doubtless had their origin in deep-seated bodies of cooling igneous rock—probably the underlying granite or granodiorite mentioned by Emmons. It was on their upward course that they found their way along the dike and through the irregular fissures.

For its entire length the [Arctic] tunnel is in Pogonip limestone. * * * At 2,050 and 2,100 feet there are two strong mineralized faults that strike N. 40° E. and mark the beginning of a series of faults of similar strike and steep northwesterly dip. At 2,300 feet a fault of this series is mineralized and forms a well-defined vein some 3 feet wide, of sheared and altered limestone stained with iron oxide. * * * Samples from this shoot assayed 25 to 162 ounces silver. * * * At 2,445 feet another fault of this series was encountered, which exposed on the west side of the crosscut quartz ore 3 feet wide that carried galena and assayed from 75 to 125 ounces silver. * * * The tunnel ends at 2,569 feet. At the face there is a zone of fine calcite stringers, some of them with quartz centers, and a few of the seams contain spots of sulphides. For 20 feet back from the face the limestone is strongly mottled with pink and white spots. These are usual indications of the proximity of a dike or ore body.

*Hilltop district.*—The Hilltop Nevada Mining Co. began the construction of a 100-ton flotation plant, which was to be completed early in 1923. Development work in the mine consisted of completing the new transportation tunnel, 2,000 feet long, from which it is planned to cut the ore by raising 700 feet from the end of the tunnel. No product from the mine or mill was shipped in 1922.

*Lewis district.*—Development work disclosed considerable milling ore in the Betty O'Neal mine. The new 100-ton flotation mill was completed, and several lots of silver-lead concentrate were sold. On October 23 the new plant of the mine started operations. The average value of the ore treated is said to be $21 a ton in gold, silver, and lead. The Betty O'Neal and Estella mines, first operated about 40 years ago, constitute the holdings of the company about 12 miles south and east of Battle Mountain, near the mouth of Lewis Canyon. The main drainage tunnel of the Betty O'Neal mine is 1,900 feet long and connects with the 300-foot level of the 330-foot shaft. Part of the tunnel level was driven in wet and heavy ground. The shipment of concentrate exceptionally rich in silver began in November.

*Reese River district.*—Two lessees in the Reese River district reported the output of 52 tons of ore, containing principally silver, mined from the Austin Manhattan and Klondyke properties.

## LINCOLN COUNTY.

*Mine production of gold, silver, copper, and lead in Lincoln County, Nev., in 1921 and 1922.*

| Year. | Number of producers. | Ore. | Gold. | Silver. | Copper. | Lead. | Total value. |
|---|---|---|---|---|---|---|---|
| | | *Short tons.* | | *Fine ounces.* | *Pounds.* | *Pounds.* | |
| 1921 | 25 | 35,088 | $8,808 | 264,304 | 338,521 | 3,104,956 | $456,504 |
| 1922 | 17 | 38,531 | 52,538 | 416,109 | 317,306 | 3,579,813 | 708,373 |
| Increase or decrease, 1922 | −8 | +3,443 | +43,730 | +151,805 | −21,215 | +474,857 | +251,869 |

*Comet district.*—Silver ore containing a little lead was mined from the Mount Comet and Stella claims, 13 miles northwest of Panaca.

*Groom district.*—Lead ore containing about 16 ounces of silver to the ton and 46 per cent of lead was mined from the Groom property and hauled 103 miles to the railroad near Las Vegas, where it was loaded for shipment to a smelter near Salt Lake.

*Highland district.*—A little lead ore containing silver and gold was mined from the Mendha and Hamburg mines. The output of the Mendha mine is included in the total for the Pioche district.

*Jack Rabbit district.*—A large output of lead ore and silver ore was shipped from the Black Metals and Bristol Silver properties. A little silver ore was also shipped to the smelter from the Silver Dale claim. The Bristol Silver mine was operated continuously, and a new inclined shaft was sunk 1,000 feet at a pitch of 70°. Development work at this depth is reported to have disclosed ore of shipping grade.

*Pahranagat district.*—Three producers in the Pahranagat district hauled 17 tons of lead ore containing silver from Hiko about 60 miles to the railroad at Caliente, where it was loaded and shipped to the smelters near Salt Lake.

*Patterson district.*—A cyanidation mill was erected and operated in November and December on ore mined from the property of the Lake Valley Mining Co. Considerable ore was treated, and the precipitates, containing principally silver, were shipped to the Selby smelter, near San Francisco.

*Pioche district.*—Six producers in the Pioche district shipped 21,390 tons of ore and old tailings in 1922. The total output contained $45,829 in gold, 230,034 ounces of silver, 44,649 pounds of copper, and 1,863,743 pounds of lead, valued in all at $384,397, or $17.97 a ton. The ore of shipping grade was mined from the Amalgamated Pioche property on company account and also by the Combined Metals Co., a lessee on part of the property. Shipments of lead ore and tailings were made from the Mendha Nevada, Prince Consolidated, Mascot Silver, and Alps mines. The average value of the district output was considerably reduced on account of the shipment of a large quantity of old tailings from the Dry Valley and Bullionville tailing dumps. Part of these tailings were shipped to Humboldt, Ariz., for use in converter linings and the remainder to a Utah smelter. New freight rates by the Union Pacific Railroad between Pioche and Caliente, Nev., and the Salt Lake Valley smelters were made effective August 30. Ore valued at $10 a ton or under was given a rate of $1.80; $11 ore took a rate of $2 a ton; and 20 cents a ton was added for each additional dollar valuation.

## LYON COUNTY.

*Mine production of gold and silver in Lyon County, Nev., in 1921 and 1922.*

| Year. | Number of producers. | Ore. | Gold.[a] | Silver.[a] | Total value. |
|---|---|---|---|---|---|
| | | *Short tons.* | | *Fine ounces.* | |
| 1921 | 24 | 8,932 | $161,575 | 22,054 | $183,629 |
| 1922 | 14 | 2,841 | 125,217 | 7,837 | 133,054 |
| Decrease, 1922 | 10 | 6,091 | 36,358 | 14,217 | 50,575 |

[a] Includes placer production.

*Mason Pass district.*—The May Adams mine, 15 miles south of Wabuska, produced a little ore from which gold bullion was recovered.

*Ramsey district.*—The 20-ton amalgamation and concentration plant of the Lahontan Mines Co. was operated on oxidized and sulphide gold ore. Several lots of bullion and concentrate were hauled 13 miles to the nearest railroad station and shipped.

*Silver City district (Palmyra, Dayton, Como).*—From the operations of six lessees and mine operators in the Silver City district 2,442 tons of ore and tailings were treated in amalgamation and cyanidation plants. The output of bullion, including the placer gold from the Gold Canyon dredge, amounted to $127,521. In the Silver City end of the district the Oest mine, which was equipped with an electric hoist in 1922, produced a little ore that yielded gold bullion at the McTigue custom amalgamation mill. The total output in the past, estimated at $1,500,000 in gold and silver, is said to have come from ore averaging $60 a ton. The bullion produced in 1922 averaged about 0.518 fine in gold and 0.457 fine in silver. Gold ore from the Well Emma mine was treated by amalgamation in a custom mill. Early in 1922 the Comstock-Eldorado Co. mined ore from the Old Wine mine. This mine and the Succor mine were purchased by the Spearhead Gold Reorganized Mining Co., which timbered the old shaft of the Succor mine for further development. Dredging was continued during the year by the Gold Canyon Dredging Co., the subsidiary of the Metals Exploration Co. The quantity of bench gravel handled during 1922 amounted to 1,087,356 cubic yards. The electric dredge on the property is equipped with buckets having a capacity of 9 cubic feet each, and the plant can handle 3,500 cubic yards of gravel daily.

*Talapoosa district.*—From the Talapoosa mine a little silver ore was shipped to the smelter and some to a custom mill at Tonopah.

## MINERAL COUNTY.

*Mine production of gold, silver, copper, lead, and zinc in Mineral County, Nev., in 1921 and 1922.*

| Year. | Number of producers. | Ore. | Gold.[a] | Silver.[a] | Copper. | Lead. | Recoverable zinc. | Total value. |
|---|---|---|---|---|---|---|---|---|
| | | *Short tons.* | | *Fine ounces.* | *Pounds.* | *Pounds.* | *Pounds.* | |
| 1921 | 36 | 7,112 | $107,622 | 47,561 | 6,184 | 111,500 | ..... | $160,998 |
| 1922 | 39 | 33,278 | 20,342 | 193,919 | 5,063 | 2,056,098 | 1,224,000 | 397,798 |
| Increase or decrease, 1922.. | +3 | +26,166 | −87,280 | +146,358 | −1,121 | +1,944,598 | +1,224,000 | +236,800 |

[a] Includes placer production.

*Bell district (Mina, Omco).*—At the Simon mine the 150-ton flotation-concentration plant was operated during the first six months of 1922, but mining operations were later suspended while a new 500-foot shaft was being sunk for the further development of the mine. Shipments of lead concentrate and zinc concentrate amounted to 3,648 tons. This company reports a reserve of 90,000 tons of ore averaging 3 ounces of silver to the ton, 5 per cent of lead, and 5 per

cent of zinc. According to published mining notes [10] the Simon Silver-Lead Mines Co. shipped lead concentrate containing 50 per cent of lead, 8 per cent of zinc, and 35 ounces of silver a ton to Midvale, Utah, for smelting. Some zinc concentrate containing 42 per cent of zinc, 6 per cent of lead, and 5 ounces of silver to the ton was shipped to a zinc oxide plant at Harbor City, Calif. In July the flotation plant was closed, and changes were made to increase the capacity to 250 tons a day. At the same time the new 3-compartment shaft was pushed to completion. Late in the year, as the price of zinc increased, arrangements were made by which a large quantity of stored zinc concentrate was shipped to the electrolytic plant at Great Falls, Mont.

*Columbus district.*—A new 300-ton cyanidation plant, constructed on the property of the Candelaria Mines Co., began operations October 26. Considerable silver ore was treated, and silver bullion containing a little gold was shipped to the mint. The annual report of the company [11] contains the following paragraphs:

> Your company had already proved up a very large tonnage of ore in the fills and dumps and in the Lucky Hill mine, hence development work was not actively carried on during the period. Since the first of January, 1923, as rapidly as tracks and pipes could be installed in the old workings of the Northern Belle mine, a number of new places have been opened up with encouraging results. Some of the new ore has been high grade, running up to 250 ounces of silver, but the average as broken down in stoping operations and sent to the mill conforms very closely to our estimate of 12 ounces for this part of the company's mines.
>
> The stoping operations carried on in Lucky Hill mine so far have shown that our engineers' valuation estimate was too high, the ore from this mine averaging about 3 ounces silver less than expected. This causes the average total content of the ore milled to be lower by 20 per cent, but by increasing the tonnage of ore treated 33 per cent we have offset this condition and maintained production with reduced unit costs. * * *
>
> Since December 1, 1921, when your present officials succeeded in their efforts to finance the company's treasury and construct the plant, a total of $360,398.86 has been expended in equipping your property for the profitable production of silver, and the plant so acquired would be appraised at a sum considerably in excess of this amount to-day as to its replacement value.

*Garfield district.*—The shaft of the Mabel mine [12] was sunk 113 feet additional, being now 218 feet deep from the tunnel level. Silver ore was developed on the two levels from the shaft and shipments made to the West End mill at Tonopah.

*Hawthorne district.*—Six mine operators in the Hawthorne district reported the shipment of 68 tons of ore containing lead and silver. One small lot of tailings was concentrated, and 25 tons of tailings treated in a cyanide plant produced some bullion. Operators of the Gold Bug Consolidated mines were actively developing this property in 1922, and production was reported from the Pamlico and La Panta mines, former producers of gold ore. A little ore was shipped from the Monte Cristo claim and the Lucky Boy mine. The operators of the Lucky Boy sunk a shaft from the tunnel level about 6,000 feet from the portal. The ore shipped was mined from the stopes above the tunnel level.

*Rand district.*—The output of four producers in the Rand district consisted of 41 tons of high-grade gold-silver ore. The Lone Star and Nevada Rand mines were the largest producers. At the Nevada

[10] Eng. and Min. Jour.-Press, May 13, 1922, p. 838; June 3, 1922, p. 978.
[11] Candelaria Mines Co. Ann. Rept. for year ending Dec. 31, 1922.
[12] West End Consolidated Mining Co. Sixteenth Ann. Rept., for year ending Dec. 31, 1922.

Rand new work on the 450-foot level disclosed a belt of highly weathered andesite, which is thought by the managers to be an indication of ore.

*Regent district (Rawhide).*—The output of 237 tons of ore mined by 11 producers in the Regent district contained $7,607 in gold and 13,451 ounces of silver, valued together at $21,058, or $88.85 a ton. Most of the ore was mined from small rich veins in andesite and was treated in a custom mill in the district.

*Santa Fe district.*—The output of 204 tons of ore credited to four properties in the Santa Fe district was all of shipping grade, with the exception of 91 tons shipped to the cyanidation mills at Tonopah. The district output contained $3,307 in gold, 2,079 ounces of silver, 372 pounds of copper, and 3,948 pounds of lead, valued in all at $5,653. Some of the ore mined from the Luning Idaho property is oxidized iron ore used for the manufacture of dry paint (metallic pigment). The company that owned the dry-color works at Richmond, Calif., to which most of this ore was shipped, reported that the plant was totally destroyed by fire in 1922. A little lead ore was mined from the Wardner group in the course of development work, and some siliceous silver ore was shipped from the Cash Boy property to a smelter near Salt Lake.

*Silver Star district (Marietta, Black Mountain).*—Six producers in Silver Star district reported the output of 133 tons of ore, all of which was of shipping grade with the exception of 55 tons that produced gold and silver bullion. Silver ore was produced from the Congress, Ibex, and Silver Dike claims, and lead ore from the Nevada Trimetallic property, at Marietta.

*Walker Lake district.*—A test lot of lead ore was shipped to the smelter from the Hematite claim.

## NYE COUNTY.

*Mine production of gold, silver, copper, and lead in Nye County, Nev., in 1921 and 1922.*

| Year. | Number of producers. | Ore. | Gold.[a] | Silver.[a] | Copper. | Lead. | Total value. |
|---|---|---|---|---|---|---|---|
| | | *Short tons.* | | *Fine ounces.* | *Pounds.* | *Pounds.* | |
| 1921 | 104 | 383,064 | $1,340,178 | 4,699,710 | 166 | 47,275 | $6,042,036 |
| 1922 | 78 | 496,122 | 1,548,170 | 5,553,563 | 2,549 | 139,109 | 7,109,728 |
| Increase or decrease, 1922 | −26 | +113,058 | +207,992 | +853,853 | +2,383 | +91,834 | +1,067,692 |

[a] Includes placer production.

*Barcelona district.*—Silver concentrates containing lead and a little copper and gold were shipped from the Spanish Belt property. The 50-ton concentration mill was operated four months testing the ore, of which the owners report a reserve of about 20,000 tons, averaging $10 a ton in gold and silver. The mine is opened by a vertical shaft 535 feet deep, and the tunnel level on the property is 1,450 feet long. The product of the mine is hauled 50 miles to the railroad.

*Bellehellen district.*—A little activity was caused by the sampling of the Clifford mine, at which the owners expected to erect a milling

plant during 1923. A small lot of gold and silver ore was shipped from the property in 1922.

*Bruner section.*—The 50-ton cyanidation plant of the Kansas City Consolidated Mines Co. at Bruner was operated on ore mined by lessees from adjoining properties. Only a small part of the ore treated came from the Kansas City Co.'s property, which is reported to have no ore of commercial value developed. The cyanide plant is equipped with ball mills, Dorr agitators, thickeners, and Portland and Merrill filters. The mill saved 90 per cent of the gold and silver in the ore treated, which came principally from the Broken Hills mine, in Churchill County.

*Bullfrog district.*—Gold bullion from the treatment of 300 tons of ore from the Mayflower mine constituted the entire output of the Bullfrog district.

*Cloverdale district.*—Lessees working on the Rosalie claim shipped a little silver ore.

*Fairplay district.*—The Lucky Jim property produced a small output of silver ore, which was shipped to a cyanidation mill at Tonopah.

*Hannapah district.*—The Silver Star and Silver Leaf claims, 20 miles from the railroad, produced several lots of silver ore which were shipped to Tonopah for treatment by cyanidation.

*Johnnie district.*—Two deep mines in the Johnnie district produced quartz ore, which was treated by amalgamation, and two surface mines yielded gold bullion, all of which was valued at $7,042. The ore milled had a recovery value of $10.83 a ton. The principal part of the output came from the Eureka Johnnie and Johnnie quartz claims.

*Mammoth district.*—During the period of operation of the Downeyville and Illinois mines lead ore was shipped to the smelters near Salt Lake City.

*Manhattan district.*—Nine operators of deep mines and 13 placer producers in the Manhattan district produced ore and bullion valued at $138,077. The output contained $137,052 in gold and 1,025 ounces of silver. All the ore was of milling grade and with a little tailing treated averaged $11.36 a ton in gold and silver. The placer-gold output was valued at $17,511. The largest output from quartz mines came from the White Caps and April Fool properties, and smaller amounts from the Manhattan Dexter, Big Pine, and Union mines. The placer claims producing most of the bullion were the Arizona Nos. 1, 2, and 3, Bulldog, China, Arlington, Hoodlum, Little Gray, Auction, Dexter No. 14, September Fraction, and Bed Rock. The White Caps Mining Co. resumed operations in September and produced about $25,000 in gold bullion a month after roasting and milling work began.

*Millett district.*—Silver and lead ore was shipped from the Twin Pine and Adirondack-Summit claims, which are in the Toyabe Range, at the heads of Clay and Ophir canyons.

*Morey district.*—A small lot of silver ore from the Smuggler claim was shipped to Tonopah. The property is opened by a tunnel 120 feet long.

*Philadelphia district (Belmont).*—Considerable old tailing from the Monitor Belmont dump was leached by straight percolation in a cyanidation plant. The work was not completed, as some tailing still remains for future treatment.

*Reveille district* (*Arrowhead*).—Silver ore was shipped from the Cascade claim and also from the property of the Southwestern Nevada Mining Co. to a cyanidation mill at Tonopah. The Arrowhead property produced a little silver-lead ore, which was shipped to a smelter near Salt Lake City.

*Round Mountain district.*—Five producers of ore in the Round Mountain district reported 2,791 tons, containing $169,818 in gold and 5,146 ounces of silver, valued together at $174,964, or $62.69 a ton. The output of bullion from placer operations was valued at $46,584. The Fairview Round Mountain, Fairview Extension, and Round Mountain mining companies were the principal producers, and the placer output, as in the past, came entirely from the Round Mountain property.

*San Antone district* (*Royston*).—Silver ore and lead ore were shipped from the Hudson property to smelters near Salt Lake City and to cyanidation mills at Tonopah for treatment. The ore contained principally silver, and some of it was unusually rich. Tailing from the San Antonio dump was treated by cyanidation, and a small lot of silver ore was shipped to the Tonopah mills from the Super Six property, which is opened by several shafts from 20 to 70 feet deep.

*Silverton district.*—Silver ore was hauled from the Treasure Hill property to a cyanidation mill at Tonopah, a distance of 88 miles. The property is developed by a 100-foot shaft and a tunnel 130 feet long.

*Tonopah district.*—The production of gold and silver in the Tonopah district increased considerably in 1922, as shown in the table below:

*Mine production of gold, silver, copper, and lead in the Tonopah district, Nevada, 1921–22.*

| Year. | Number of producers. | Ore. | Gold. | Silver. | Copper. | Lead. | Total value. |
|---|---|---|---|---|---|---|---|
| | | *Short tons.* | | *Fine ounces.* | *Pounds.* | *Pounds.* | |
| 1921 | 25 | 367,909 | $999,094 | 4,623,901 | ..... | ..... | $5,622,995 |
| 1922 | 16 | 472,865 | 1,179,302 | 5,436,080 | ..... | ..... | 6,615,382 |
| Increase or decrease, 1922 | −9 | +104,956 | +180,208 | +812,179 | ..... | ..... | +992,387 |
| Total, 1904–1922 | ..... | 6,781,837 | 30,267,663 | 138,341,244 | 12,113 | 214,523 | 122,865,447 |

The Belmont mine, for several years prior to 1922 the largest producer of silver in Nevada, mined 125,434 tons of ore and waste. The total ore mined amounted to 87,778 dry tons, which was of slightly higher grade but less by 29,192 tons than the output of 1921. This ore had a gross metal content of 11,295 ounces of gold and 1,161,503 ounces of silver, or a gross value of $1,394,999, and averaged 0.128 ounce of gold and 13.16 ounces of silver to the ton, or a value of $15.81. Costs of mining and milling, as given in the annual report of the Tonopah Belmont Development Co.,[13] are as follows:

The mining, milling, and general costs on the Belmont mine ores were $10.94 a ton, as compared with $9.52 per ton of the previous year. Shipping and marketing costs were $0.253 per ton, as compared with $0.278 per ton in the year previous. Tailings losses were $0.851 and metal losses were $0.002 per ton, as compared with $1.246 and $0.015 in the previous year. The Tonopah operating profits were $3.712 per ton, or

[13] Tonopah Belmont Development Co. Twentieth Ann. Rept., for year ending Dec. 31, 1922.

$0.553 per ton lower than in the preceding year. The percentage of profit on Belmont mine ores was 23.5 per cent in 1922, as compared with 27.8 per cent in 1921 and with 30.1 per cent in 1920. * * *

The direct mining costs of the 87,778 dry tons of ore mined was $6.889 per ton, an increase of $1.593 per ton, as compared with the $5.296 per ton for the 117,183 dry tons of ore mined in the previous year. The direct mining cost per ton of the 125,434 tons of ore and waste broken was $4.827, as compared with $4.241 per ton for 146,046 tons of ore and waste broken in 1921. Indirect mining costs per ton of ore were $0.912, as compared with $0.626 per ton in the previous year. Total mining costs were $7. 810 per ton of ore, an increase of $1.888 per ton over the total mining costs of $5.922 per ton of ore for the year preceding.

Direct stoping costs were $5.392 per ton, as compared with $4.357 in the previous year. Direct development costs were $1.507 per ton, as compared with $0.939 in the year previous. Direct mining costs per ton in 1922 were made up of $4.591 per ton for labor, $1.995 per ton for supplies, and $0.303 per ton for power, as compared with $3.443, $1.632, and $0.221, respectively, in 1921.

The milling costs per ton of custom ores were, because of higher grade and more refractory character of the ore and on account of the extra handling required, considerably higher than the per ton milling costs of Belmont mine ore. The total milling costs per ton of custom ores were considerably higher than similar costs of the previous year. * * *

The recovery of the gold was 95.99 per cent, of the silver 94.43 per cent, and of the combined money values 94.45 per cent. * * *

The concentrate treatment plant operated continuously throughout the year, treating 560,374 dry tons of concentrates at a cost of $12.123 per ton of concentrates, or $0.054 per ton of ore. * * *

The "sweepings" plant was operated only during a part of July and August, the plant treating 1,053 dry tons of a gross value of $33,304.89 and a per ton value of $31,629. Heavy rains in August destroyed the "crop" of sweepings to such an extent that the plant was shut down for the season, and the small remaining tonnage of sweepings received were treated in the main mill. * * *

The combined production of the mills (Tonopah and Millers plants) for the year was 27,952.647 ounces of gold and 2,055,471.41 ounces of silver. The output of gold was sold for an average price of $20.6692 per fine ounce ($20.6718 per ounce for 27,908.995 ounces of gold in bullion and $19 per ounce for 43.652 ounces of gold in by-products shipped to the smelters). The output of silver was sold at an average price of $0.9998 per ounce ($1 per ounce for 2,048,097.87 ounces of silver in bullion and $0.9464375 for 7,373.54 ounces of silver in by-products). The mill production was about 25.1 per cent of the total silver production of Nevada in 1922 and was about 36.3 per cent of the silver production of the Tonopah district.

Ore shipments from the Rescue-Eula mine [14] during the fiscal year amounted to 3,565 dry tons, containing 863.28 ounces of gold and 78,463 ounces of silver, valued at $95,706. The ore averaged $26.99 a ton and was shipped to one of the plants of the Belmont Co. through the underground workings of the Belmont mine, which the property adjoins. Hauling, freight, treatment, and milling losses amounted to $31,087, and the net returns from ore produced were $64,619.

Work in the Tonopah mine [15] was conducted through the Mizpah, Silver Top, and Sand-Grass shafts, which produced 75,379 tons of ore shipped to the company's mill at Millers. The average content of the mine ore shipped was 0.135 ounce of gold and 12.42 ounces of silver to the ton, or a value of $15.22. Profits from the mine amounted to $328,465.95, or $4.36 a ton. The mining cost was $5.24 a ton in 1922, compared with $6.89 in 1921, and the cost of milling was $3.42 a ton, compared with $4.17 in 1921. A recovery of 93.2 per cent of the gold and 91.4 per cent of the silver was made at the plant at Millers, where 11,408 tons of custom ore was also treated in 1922.

[14] Rescue-Eula Mining Co. Ann. Rept. for year ending May 31, 1922.
[15] Tonopah Mining Co. of Nevada Twenty-first Ann. Rept., for year ending Dec. 31, 1922,

The Tonopah Extension Co.,[16] the largest producer of silver in Nevada in 1922, increased its area of mining claims from 669.65 acres to 792.25 acres by the purchase of the property of the West Tonopah Consolidated Mining Co. Altogether 134,801 tons of ore was mined and milled, which contained 12.68 ounces of silver and 0.129 ounce of gold to the ton. The total value of the ore was $2,068,060, or $15.34 a ton. The tailing contained $1.38 a ton. The recovery was 1,549,266 ounces of silver and 16,187.82 ounces of gold, valued together at $1,881,769.86. The cost of mining, including development work, was $5.57 a ton, milling $3.53, and marketing $0.22, or a total cost of $9.32. With the metal loss in tailing of $1.382 and the cost of depreciation, etc., amounting to $0.414 a ton, the total cost was $11.115 a ton. The net realization per ton of ore was $4.27 a ton. Most of the development work was done from the Victor shaft, which was sunk 136 feet to the 2,000-foot point. The pumping plant on the 1,540-foot level of the McKane shaft, which handles a flow of 300 gallons of water a minute, was put in operation. It has been demonstrated that pumping from this shaft lowers the water in the newly acquired West Tonopah shaft, 950 feet deep, which heretofore could not be worked on account of the flow of water. The most notable event in Tonopah during 1922 was the opening of considerable silver ore on the 1,880-foot level near the Victor shaft. The Murray vein on this level is said to be 80 to 100 feet wide, averaging more than $20 a ton. The ore body has been opened for a length of 600 feet, and the west face was still in ore at the end of 1922.

The West End property[17] produced 98,181 tons of ore, containing 16,199.18 ounces of gold and 1,504,255 ounces of silver, which had a gross value of $1,836,303.74, or an average of $18.70 a ton. Of this ore, 60,256 tons came from the Ohio vein and its branches, 33,869 tons from the West End vein, and 4,056 tons from the Fraction vein. A lease on the Jim Butler property yielded 486 tons of ore, valued at $11,816, or $24.31 a ton. The average mining cost for the year, including operations in leased ground, was $5.28 a ton. Milling of the ore cost $2.93 a ton. In addition to the ore milled at the West End and MacNamara mills, 7,346 dry tons of ore was shipped to the Millers plant of the Tonopah Mining Co. The treatment of ore from the West End, Jim Butler, Halifax, and Mabel mines at the West End mill yielded 13,784.18 ounces of gold and 1,319,020 ounces of silver, which represents a recovery of 93.56 and 92.14 per cent, respectively.

From the Tonopah Midway mine[18] ore containing gold and silver valued at $3,817 was produced from development work confined to the 1,100, 1,200, and 1,600 levels connected with the new shaft. Owing to the intense heat due to the lack of adequate ventilation, it was difficult to obtain miners to work on the 1,600-foot level. Work was discontinued until connection can be made between the 1,200 Midway level and the Tonopah Extension 1,050 level.

The Jim Butler mine[19] produced 3,329 dry tons of ore, containing 457.17 ounces of gold and 41,225 ounces of silver, valued at $50,661. This ore was mined entirely by lessees and averaged 0.137 ounce of gold, 12.38 ounces of silver, and in value $15.21 a ton.

[16] Tonopah Extension Mining Co. Ann. Rept. for year ending Mar. 31, 1923.
[17] West End Consolidated Mining Co. Sixteenth Ann. Rept., for year ending Dec. 31, 1922.
[18] Tonopah Midway Mining Co. Ann. Rept. for year ending Dec. 31, 1922.
[19] Jim Butler Tonopah Mining Co. Ann. Rept. for year ending Dec. 31, 1922.

*Union district.*—Bullion was recovered by using a rocker and sluice boxes in re-treating tailing from the old mill of the Berlin property. Lead ore from the Alexander mine, operated by the Webster Mines Corporation, was treated in a 40-ton concentration plant.

### PERSHING COUNTY.

*Antelope district.*—The Antelope Springs property yielded lead ore shipped by lessees. The company reported a reserve of about 10,000 tons of ore, carrying 11 ounces of silver to the ton, 1.95 per cent of copper, 13 per cent of lead, and 15 per cent of zinc. The mine is opened by 3,000 feet of tunnels and raises, and the ore is shipped either from Jungo, on the Western Pacific Railroad, or from Humboldt, on the Southern Pacific Railroad.

*Arabia district.*—Several lots of lead ore containing antimony were shipped from the Last Chance and Montezuma & Jersey properties, worked by the owners or lessees.

*Jersey Valley district.*—Lessees shipped one lot of silver ore from the Rex claims. The shipping point is Battle Mountain, on the Southern Pacific Railroad.

*Kennedy district.*—Three producers in the Kennedy district shipped 7 tons of silver ore from the Fourth of July, Independence, and Silver Star claims which averaged $191.86 a ton in gold and silver.

*Rochester district.*—Ten producers in the Rochester district produced 116,138 tons of milling ore and 317 tons of sweepings from tailing ponds. The total product of the district, including the bullion from the operations of one surface mine, consisted of $107,033 in gold and 800,238 ounces of silver, valued together at $907,271. The ore and sweepings had an average value of $7.80 a ton. Most of the output was produced from the property of the Rochester Silver Corporation and the Nevada Packard Co. Gold bullion was recovered from ore treated in the 2-stamp amalgamation mill of the Great Western Mines Co., and gold ore from the Argentor and Octopus properties was treated by cyanidation.

The Rochester Silver Corporation [20] treated 50,875 tons of company ore, 5,387 tons of ore mined by lessees, and 650 tons of custom ore. The total value of gold and silver produced was $598,169.74, equal to $10.33 a ton. Operations resulted in a profit of $131,722.61 after deducting all operating and administrative costs, before allowing for depreciation and depletion and adding interest earned. The recovery for the year was 90.9 per cent of the gold and 83.4 per cent of the silver. The total gold produced amounted to 2,883.5 ounces, or 0.05 ounce per ton of ore treated, and the total silver was 538,565 ounces, or 9.68 ounces per ton. From the annual report of the corporation the following paragraph is taken:

> Reviewing the results of the year's work we feel that our operations have resulted more favorably than we could have predicted at the commencement of the period. The position of the ore reserve was considerably weakened then; nevertheless, the largest tonnage of any year in the company's life was mined and milled, a satisfactory profit was earned, and dividends totaling $133,155 were distributed to shareholders.

The Nevada Packard mine, in the south end of the Rochester district, started production in May under the management of a receiver. A large quantity of rather low grade ore containing silver

[20] Rochester Silver Corporation Ann. Rept. for year ending Dec. 31, 1922.

with very little gold was treated by cyanidation. Valuable new ore bodies were said to have been opened in the mine, and the mill was overhauled and repaired to treat 160 to 175 tons of silver ore daily.

*Rosebud district.*—A small lot of silver ore was shipped by lessees who worked the Grubstake property, 2 miles from Sulphur, on the Western Pacific Railroad.

*Seven Troughs district.*—Small leasing operations on the surface of the property of the Seven Troughs Reorganized Mines Co. and two small lots of ore produced from other properties in the Seven Troughs district resulted in the production of gold and silver bullion valued at $4,088.

*Sierra district (Dun Glen, Central, Sunshine).*—Four properties in the Sierra district produced 29 tons of ore. All the ore from Dun Glen contained gold, which was recovered by amalgamation and shipped to the mint. The Chloride property of the Sunshine Mines Co. was operated and produced oxidized lead ore containing silver.

*Unionville district (Buena Vista).*—Five properties in the Unionville district produced 2,274 tons of ore, nearly all of which was of milling grade. Most of the ore was treated by cyanidation or by concentration. Only one small lot of ore was shipped directly to the smelter. The total output of the district contained $1,100 in gold, 22,143 ounces of silver, 531 pounds of copper, and 1,427 pounds of lead, valued in all at $23,393, or $10.29 a ton. The Arizona Silver property was the largest producer, and considerable silver bullion was recovered in the newly completed cyanidation plant. Ore mined from the Silver Reef mine was said to assay 12 to 16 ounces of silver to the ton, and stope fillings from the Arizona mine assayed 6 to 15 ounces to the ton. During development work at the Unionville mine some ore was milled which yielded gold bullion. At the Rye Patch property lessees erected a 40-ton cyanide plant and started to treat the mine fills and dumps by cyanidation, but owing to the shortage of water the plant was closed.

## STOREY COUNTY.

*Mine production of gold and silver in Storey County, Nev., in 1921 and 1922.*

| Year. | Number of producers. | Ore. | Gold. | Silver. | Total value. |
|---|---|---|---|---|---|
| | | *Short tons.* | | *Fine ounces.* | |
| 1921 | 17 | 64,601 | $324,827 | 263,931 | $588,758 |
| 1922 | 15 | 138,752 | 298,409 | 329,644 | 628,053 |
| Increase or decrease, 1922 | −2 | +74,151 | −26,418 | +65,713 | +39,295 |

All the output of ore and metal given in the table for Storey County came from the Comstock district. Most of the ore was milled, but the total included 1,275 tons of old tailings re-treated and 88 tons of silver ore containing gold shipped directly to the smelter. A large part of the ore was mined from the property of the United Comstock Mines Co., which started its new cyanidation mill September 20 and operated it at one-third of its capacity of 2,000 tons during the last quarter. About 30,000 tons of ore from the Consolidated Virginia mine and more than 2,000 tons from the Ophir property

was treated by cyanidation in the Mexican custom mill. The Comstock Leasing Co., operating the Chollar and Potosi properties, treated gold and silver ore in its own cyanidation mill, which has a capacity of 75 tons daily. The Comstock Home and Comstock Phoenix properties were both being developed, and several small lots of ore and bullion were shipped. The Justice mine was worked by lessees, who treated the lower-grade ore containing gold and silver at the McTigue mill at Silver City and shipped the higher-grade ore directly to the smelter. Much interest has been centered on the newly constructed mill of the United Comstock Mines Co. An essential step in the process employed is the preliminary washing of the ore in Akins machines. This treatment reduces the consumption of cyanide and lime and hastens the settling of the ore. Four different products are made by classification and concentration—primary slime, secondary slime, sand tailing, and sand concentrate. The two classes of slime and the concentrate after regrinding undergo agitation and filter treatment; the sand tailing is leached by percolation. The primary slime, which is of a higher grade than the secondary slime, receives a proportionately more elaborate treatment. The treatment of the concentrate, for the same reason, is still more elaborate. Moore filters are used. The ore is of low grade and not easily cyanided. The plant has been described fully in a recent article by George J. Young.[21]

### WASHOE COUNTY.

*Leadville district.*—The mill of the Leadville Mines Co. was not started until May, after which considerable ore was treated. Lead concentrate with some first-class ore was shipped to the smelter from Gerlach, on the Western Pacific Railroad. The mine is opened to a depth of 400 feet by tunnels and was producing at the rate of about 1,000 tons a month in September. The ore milled was said to contain 28.08 ounces of silver to the ton and 6.5 per cent of lead, and the average recovery was about 92.5 per cent.

*Peavine district.*—Surface ore from the Gold Bond claim, which contains principally silver, was hauled 12 miles to the nearest railroad station. At the Standard Metals mine development work on the 400-foot level is said to have disclosed ore worth about $20 a ton, on which a drift was run for 35 feet.

*Wedekind district.*—Several lots of sulphide lead ore were shipped from the Wedekind mine.

*White Horse district.*—Seven producers in the White Horse district shipped gold and silver ore valued at $3,931. One small lot of bullion was also recovered from placer operations. Lessees mined ore from the Green Hill, Hutchinson, Keystone, Renegade, and Springfield-Nevada properties and had it treated at a local custom mill equipped for amalgamation.

[21] Eng. and Min. Jour.-Press, Nov. 11, 1922, pp. 846–853.

## WHITE PINE COUNTY.

*Mine production of gold, silver, copper, lead, and zinc in White Pine County, Nev., in 1921 and 1922.*

| Year. | Number of producers. | Ore. | Gold.[a] | Silver.[a] | Copper. | Lead. | Recoverable zinc. | Total value. |
|---|---|---|---|---|---|---|---|---|
| | | *Short tons.* | | *Fine ounces.* | *Pounds.* | *Pounds.* | *Pounds.* | |
| 1921 | 28 | 402,335 | $90,632 | 54,570 | 10,297,756 | 447,167 | ..... | $1,493,736 |
| 1922 | 30 | 633,505 | 104,588 | 87,434 | 22,633,276 | 736,737 | 484,666 | 3,315,661 |
| Increase, 1922 | 2 | 231,170 | 13,956 | 32,864 | 12,335,520 | 289,570 | 484,666 | 1,821,925 |

[a] Includes placer production.

*Cherry Creek district.*—Four producers in the Cherry Creek district mined 889 tons of ore, containing $5,110 in gold, 24,469 ounces of silver, 1,567 pounds of copper, and 2,963 pounds of lead, valued in all at $29,954, or $33.69 a ton. All this ore, with the exception of 4 tons treated in a milling plant, was of shipping grade and was produced from the Black Metals, Exchequer, North Mountain, and Silver Standard properties.

*Duck Creek district.*—Lessees shipped several lots of lead ore from the Ely Amalgamated and Hyrum properties.

*Newark district.*—At the Newark mine lessees produced silver ore containing a little lead and copper.

*Osceola district.*—A large quantity of gold bullion was recovered from ore mined from the Sunrise group. The placer output consisted of bullion from the Dry Gulch and Fifth Decade properties and small lots from operators of unknown claims.

*Robinson district.*—The value of the metal output of the Robinson district was double that of 1921, though the output is still below normal. Most of the output was copper ore from the Nevada Consolidated property, which produced both milling and shipping ore. Several thousand tons of first-class copper ore was also shipped from the Boston-Ely mine.

*Mine production of gold, silver, copper, lead, and zinc in the Robinson district, White Pine County, Nev., 1921–22.*

| Year. | Number of producers. | Ore. | Gold. | Silver. | Copper. | Lead. | Recoverable zinc. | Total value. |
|---|---|---|---|---|---|---|---|---|
| | | *Short tons.* | | *Fine ounces.* | *Pounds.* | *Pounds.* | *Pounds.* | |
| 1921 | 4 | 400,810 | $82,626 | 16,069 | 10,282,527 | 37,809 | ..... | $1,426,843 |
| 1922 | 8 | 630,871 | 92,825 | 27,477 | 22,614,736 | 216,562 | 484,666 | 3,212,828 |
| Increase, 1922 | 4 | 230,061 | 10,199 | 11,408 | 12,332,209 | 178,753 | 484,666 | 1,785,985 |
| Total, 1904–1922 | ..... | 38,617,941 | 6,306,044 | 1,115,723 | 866,476,433 | 3,012,806 | 5,447,318 | 167,447,550 |

Considerable lead ore and zinc ore was produced by the Consolidated Coppermines Co. through lessees. Zinc ore from the Ely Calumet property was shipped to the zinc oxide plant of the Utah Zinc Co. at Murray, Utah. The Ely Calumet Co. reports a reserve of ore estimated at 25,000 tons, said to contain 20 per cent of zinc.

The shipping ore is hauled 4 miles southeast to the railroad station at East Ely. A little lead ore from the Hidden Treasure claim was shipped to a smelter in Utah.

The Nevada Consolidated property [22] was idle until the middle of April, when operations were resumed first at the mines, then at the concentration plant, and later at the smelter. After a fire at the mill, July 9, 1922, costs of operation in all departments were necessarily high owing to the small production and correspondingly high overhead expense. The company's annual report contains the following paragraphs:

> Prospecting was continued in a limited way during the past year, principally on the Ruth group of claims, both with surface and underground drills. This for the purpose primarily of further outlining the new discovery of contact ore in and near the limestones. Moderate extension of this direct smelting ore body in the sedimentaries below the 700 level was proved, showing enrichment at the 800 level. Extension laterally also indicated that ore of 7 per cent grade was being pierced by a group of prospect drill holes in the limestone hanging wall approximately 600 feet westerly from the developed contact ore body. This development was not, however, sufficiently advanced to represent additional blocked tonnage but is indicative of the possibility of enrichment in the heavily faulted hanging-wall zone lying west of the Ruth porphyry area. * * *
>
> Total tonnage milled in 1922 was 518,523 dry tons averaging 1.60 per cent copper, as compared with 392,645 dry tons averaging 1.49 per cent copper for the short operating period in 1921. The mill recoveries of copper in concentrates in 1922 were materially under the first two months of 1923, when the plant was operating under more favorable conditions, being free from the interferences of the construction forces. There is every reason to believe that normal mill extraction in the reconstructed concentrator will average 85 per cent or better. * * *
>
> Production of refined copper during the 1922 operating period was 23,762,675 pounds, as compared with 9,362,325 pounds for the three months operating period of 1921, and 90,735,287 pounds in 1916, the last preceding year of full-capacity production.
>
> Excluding depreciation of plant and equipment, but including all taxes, general and other overhead expenses, the total operating cost per pound of copper produced was 9.62 cents, after applying, as usual, credits for gold and silver and miscellaneous earnings, as compared with a 12.34 cents per pound cost, similarly calculated, for the year 1921.

*Ward district (Taylor).*—From the Nevada United mine a large quantity of oxidized lead ore containing silver was shipped to the smelter by the Ward Leasing Co.

*White Pine district.*—All the ore (334 tons) produced by seven operators in the White Pine district was of shipping grade. The output contained $157 in gold, 5,999 ounces of silver, 11,516 pounds of copper, and 285,023 pounds of lead, valued in all at $23,387, or $70.02 a ton. Copper ore was shipped from the Dover mine, copper-lead ore from the Great Valley and Leath, and lead ore from the Jennie A., Nevada, Rocco Homestake, and White Pine properties.

[22] Nevada Consolidated Copper Co. Sixteenth Ann. Rept., for year ending Dec. 31, 1922.

# IRON ORE, PIG IRON, AND STEEL.

By Ernest F. Burchard and Hubert W. Davis.

## GENERAL REVIEW.

After the period of severe depression and great uncertainty in the iron industry that began in the autumn of 1920 and continued until late in 1921, conditions at the beginning of 1922 were still unsettled but appeared to have passed the crisis and to be once more improving. Prophesies made early in 1922 were conservative, indicating that a more active but subnormal demand for iron ore might be expected, and therefore there was no great disappointment when the total output of iron ore for the year proved to be less than 80 per cent of the averages for the preceding 5 and 10 year periods, but naturally there was considerable satisfaction in the increases of 60 per cent and 90 per cent, respectively, in production and shipments of ore as compared with 1921. The production of iron ore in 1922 ranked about with that of 1906. The output of pig iron increased 64 per cent as compared with 1921 and was equal to about 86 per cent of the average for the preceding 10-year period and about 84 per cent of the average for the preceding 5 years. The quantity corresponded closely with that manufactured in 1910 and was less than for most of the succeeding years.

The average price per ton for iron ore at the mines decreased about 7 per cent and that of pig iron at the blast furnaces about 9 per cent. Low prices for pig iron in the first three months of the year may have been a factor in stimulating trade. The quoted prices of ferromanganese, spiegeleisen, and steel showed nearly the same range as in 1921. Profits are generally considered to have been small notwithstanding the greater volume of business in 1922, and the quarterly reports of several steel companies showed deficits in the first nine months of the year.

No serious labor disturbances occurred directly in the iron mining or manufacturing fields, although, of course, the effects of the strikes of the bituminous coal miners and the railway shopmen were keenly felt. In the Lake Superior iron-mining districts at the end of 1921 many mines that had been shut down on account of lack of demand were put into operation mainly in order to furnish employment to the needy miners. Wages were necessarily reduced, but in May, 1922, the wage scales of the later part of 1921 were restored, and in September advances of 10 and 15 per cent were made. A shortage of mine labor began to be felt in September through the influence of

increased industrial activity and restricted immigration. In the iron and steel industry labor shortage was felt early in the summer, and a general wage advance of 20 per cent was made early in the autumn as a means of checking the emigration of foreign-born workmen. A movement toward the abolition of the 12-hour day in the steel industry was made by the President of the United States at a conference with representative manufacturers in May and was followed by a serious effort on the part of the manufacturers to find ways and means to accomplish this end.

One feature of the year was a movement toward the consolidation of seven important steel-manufacturing companies, which terminated in the acquisition of certain of these companies by subsidiaries of the Bethlehem Steel Corporation and the consequent entry by this concern into the Lake Superior iron-ore field. Heretofore the Bethlehem furnaces have depended largely on ores from Cuba, Chile, Sweden, and Spain, but for the recently acquired plants farther west Lake ores will be more of a necessity.

Buying of iron and steel was stimulated to some extent by the scarcity of stocks at the end of 1921, but the demand was not uniform during 1922, and only in the autumn was a large percentage of manufacturing capacity utilized. To building construction, which is regarded as having established a record for value in 1922, is to be ascribed one of the most sustained demands, and the railroads and automobile manufacturers were fairly heavy buyers. Demand for iron and steel for agricultural uses, for oil-well drilling, and for shipbuilding were relatively low. The coal strike, which lasted five months, naturally affected the situation greatly, retarding production and increasing prices, and the railroad shopmen's strike seriously interfered with the movement of raw materials and finished products.

The total domestic output of pig iron probably required about 52 per cent of the apparent maximum capacity of the country, according to figures of the American Iron and Steel Institute, but this capacity was not utilized steadily, for at the beginning of 1922 there were only 125 furnaces in blast; on June 30 there were 201; and at the end of the year, 263. The production of steel ingots is considered to have utilized about 61 per cent of the manufacturing capacity, the output having ranged from less than 50 per cent of capacity in August to 80 per cent late in the year; a higher percentage was precluded by the restrictions of transportation facilities and labor supply. The pig-iron output of the United States represented more than one-half of the world's production and nearly twice that of all the principal producing countries of Europe combined. The production of these European countries increased only about 41 per cent, compared with the increase of 64 per cent in the United States. Decreases in export figures indicate that the United States is not contributing large quantities of iron and steel toward the rehabilitation of Europe, and increases in imports from war-stricken European countries indicate that their products are already invading American markets.

The tariff act of 1922 placed on the free list iron ore, including manganiferous iron ore, and the dross or residuum from burnt pyrites. On the dutiable list was placed iron in pigs, iron kentledge, spiegeleisen containing more than 1 percentum of carbon and less than 30 per cent of manganese, 75 cents per ton; wrought and cast scrap iron and

scrap steel, valued at not more than 7 cents per pound, 75 cents per ton.

The major items of the statistics of iron ore, pig iron, and ferroalloys given in the following pages were issued as a press bulletin on June 4, 1923, and estimates of iron-ore output were published January 22, 1923.

Publications of the United States Geological Survey on iron-ore deposits issued in 1922 were as follows:

Bayley, W. S., Brown hematite ores of western North Carolina: Bulletin 735–F, 51 pp.

Bayley, W. S., General features of the magnetite ores of western North Carolina and Eastern Tennessee: Bulletin 735–G, 61 pp.

## IRON ORE.

### QUANTITIES MINED AND SHIPPED IN 1922.

The quantities of iron ore shown in the accompanying table include beneficiated ore instead of crude ore mined if the ore is treated in any way. The quantities of ore, both mined and shipped, stated in the tables include the iron ore used for fluxing other metallic ores at smelters in the Western States, but the shipments do not include the iron ore sold for the manufacture of paint, which amounted in 1922 to 27,382 gross tons, valued at $166,682, or $6.09 a ton, compared with 10,379 tons, valued at $56,824, or $5.47 a ton, in 1921. The manganiferous iron ore (including ore used for flux), which contained 5 per cent or more of manganese, amounted to 625,659 gross tons, valued at $1,766,419.

Iron ore was mined in 20 States in 1922, as compared with 22 States in 1921, Massachusetts and Texas having dropped out. California, Idaho, Montana, and Utah produced iron ore for flux only; part of the ore produced in Michigan and Nevada was used for flux; a small quantity of ore from Virginia was used in the manufacture of hydrogen gas; some of the ore from Pennsylvania was used for gas purification; the remaining States produced iron ore mainly for use in blast furnaces, except small quantities used for paint from Michigan, Missouri, Nevada, New York, Pennsylvania, Tennessee, and Wisconsin. The rank of the three States producing the largest quantity of iron ore—Minnesota, Michigan, and Alabama—remained practically unchanged. The Minnesota iron ranges are producing more iron ore than all the rest of the States together, having furnished between 58 and 61 per cent of the total for the United States in recent years.

The ores of iron are classed under the four heads hematite, brown ore, magnetite, and carbonate. [1]

[1] Notes concerning the composition of these ores are given in U. S. Geol. Survey Mineral Resources, 1916, pt. 1, pp. 537–541, 1918.

*Iron ore mined in the United States in 1921 and 1922, by States and varieties, in gross tons, with percentage of increase or decrease in 1922.*

[Exclusive of ore containing 5 per cent or more of manganese.]

| State. | Hematite. | Brown ore. | Magnetite. | Carbonate. | Total. | Percentage of increase or decrease in 1922. |
|---|---|---|---|---|---|---|
| **1921.** | | | | | | |
| Alabama | 2,644,020 | 232,121 | | | 2,876,141 | |
| California | | | 2,064 | | 2,064 | |
| Colorado | | 3,823 | | | 3,823 | |
| Georgia | 1,009 | 4,547 | | | 5,556 | |
| Idaho | | 799 | | | 799 | |
| Massachusetts | | 4,100 | | | 4,100 | |
| Michigan | 7,283,492 | | | | 7,283,492 | |
| Minnesota | 17,811,325 | | | | 17,811,325 | |
| Missouri | 36,550 | | | | 36,550 | |
| Montana | 5,239 | 3,695 | 17,240 | | 26,174 | |
| Nevada | | 268 | | | 268 | |
| New Jersey | | | 58,589 | | 58,589 | |
| New Mexico | [a] 43,146 | | [a] 67,382 | | 110,528 | |
| New York | 2,445 | | 467,543 | | 469,988 | |
| North Carolina | | 2,583 | | | 2,583 | |
| Pennsylvania | | 974 | 142,966 | 2,709 | 146,649 | |
| Tennessee | 13,416 | 12,293 | | | 25,709 | |
| Texas | | 131 | | | 131 | |
| Utah | (b) | [b] 35,691 | 25,082 | | 60,773 | |
| Virginia | 4,892 | 69,129 | | | 74,021 | |
| Wisconsin | 257,014 | | | | 257,014 | |
| Wyoming | 234,701 | | | | 234,701 | |
| | [ab]28,337,249 | [b] 370,154 | [a] 780,866 | 2,709 | 29,490,978 | |
| **1922.** | | | | | | |
| Alabama | 4,619,395 | 615,173 | | | 5,234,568 | +82 |
| California | | | 3,204 | | 3,204 | +55 |
| Colorado | | 513 | | | 513 | −87 |
| Georgia | 120 | 24,029 | | | 24,149 | +335 |
| Idaho | | 200 | | | 200 | −75 |
| Michigan | 10,453,578 | | | | 10,453,578 | +44 |
| Minnesota | 28,748,106 | | 20,854 | | 28,768,960 | +62 |
| Missouri | 57,038 | 1,370 | | | 58,408 | +60 |
| Montana | (b) | [b] 21,726 | | | 21,726 | −17 |
| Nevada | | 51 | | | 51 | −81 |
| New Jersey | | | 90,359 | | 90,359 | +54 |
| New Mexico | | | 118,038 | | 118,038 | +7 |
| New York | 14,769 | | 429,612 | | 444,381 | −5 |
| North Carolina | | 12,958 | 4,321 | | 17,279 | +569 |
| Pennsylvania | | 861 | 776,719 | 3,256 | 780,836 | +432 |
| Tennessee | 74,928 | 81,536 | | | 156,464 | +509 |
| Utah | (b) | [b] 6,355 | 8,663 | | 15,018 | −75 |
| Virginia | 12,161 | 18,810 | | | 30,971 | −58 |
| Wisconsin | 575,828 | | 1,196 | | 577,024 | +125 |
| Wyoming | 332,800 | | | | 332,800 | +42 |
| | [b] 44,888,723 | [b] 783,582 | 1,452,966 | 3,256 | 47,128,527 | +60 |

[a] Some magnetite included with hematite. [b] Some hematite included with brown ore.

The ore reported as sold for fluxing other than the manufacture of pig iron amounted to 40,155 gross tons, valued at $143,100, as compared with 89,959 tons, valued at $265,968, in 1921. The ore reported as sold for purifying gas and for the manufacture of hydrogen amounted to 870 gross tons, valued at $8,998, compared with 1,101 tons, valued at $9,980, in 1921. The domestic iron ore sold for the manufacture of pig iron amounted to 50,571,595 gross tons, valued at $157,657,188, compared with 26,561,468 tons, valued at $89,469,360, in 1921.

A comparison of the annual production of iron ore and its derived metals pig iron and steel since 1870 is afforded by the curves shown in Figure 11. The figures for the three products are not strictly comparable, however, because considerable foreign iron ore and also some cinder, scale, and scrap enter into the production of domestic

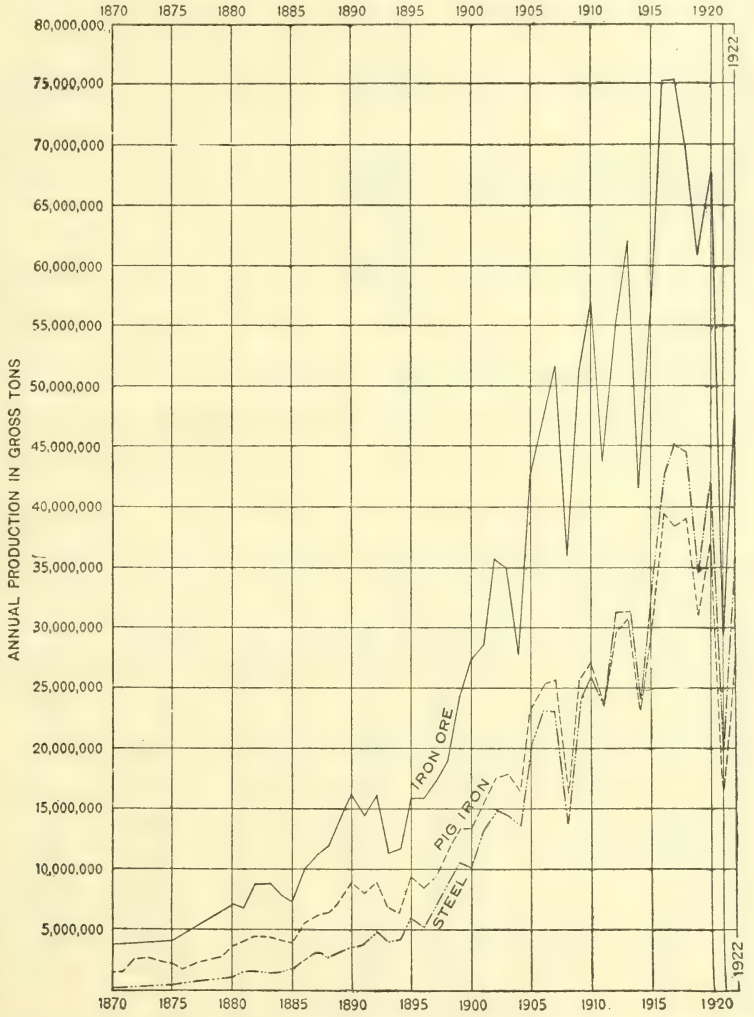


FIGURE 11.—Curves showing annual production of iron ore, pig iron, and steel in the United States, 1870–1922.

pig iron, and considerable scrap iron and steel, as well as cinder and scale, enter into the production of new steel.

In response to inquiries as to the quantities of iron ore used for paint and flux the shipments by States have been subdivided into the several uses reported as shown in the next table.

*Iron ore shipped from mines in the United States in 1922, by States and uses, in gross tons.*

[Exclusive of ore containing 5 per cent or more of manganese.]

| State. | Pig iron. | Flux. | Paint. | Other. | Total. |
|---|---|---|---|---|---|
| Alabama | 5,294,520 | | | | 5,294,520 |
| California | | 3,204 | | | 3,204 |
| Colorado | 513 | | | | 513 |
| Georgia | 28,566 | | | | 28,566 |
| Idaho | | 25 | | | 25 |
| Massachusetts | 4,368 | | | | 4,368 |
| Michigan | 12,457,699 | 157 | 3,971 | | 12,461,827 |
| Minnesota | 30,209,372 | | | | 30,209,372 |
| Missouri | 58,320 | | 38 | | 58,358 |
| Montana | | 21,726 | | | 21,726 |
| Nevada | | 25 | 26 | | 51 |
| New Jersey | 90,374 | | | | 90,374 |
| New Mexico | 118,038 | | | | 118,038 |
| New York | 191,195 | | 14,769 | | 205,964 |
| North Carolina | 19,279 | | | | 19,279 |
| Pennsylvania | 782,255 | | 3,256 | 661 | 786,172 |
| Tennessee | 159,473 | | 700 | | 160,173 |
| Utah | | 15,018 | | | 15,018 |
| Virginia | 30,150 | | | 209 | 30,359 |
| Wisconsin | 794,673 | | 4,622 | | 799,295 |
| Wyoming | 332,800 | | | | 332,800 |
| | 50,571,595 | 40,155 | 27,382 | 870 | 50,640,002 |

*Iron ore shipped from mines in the United States, 1921 and 1922, by States.*

[Exclusive of ore containing 5 per cent or more of manganese and of ore sold for paint.]

| State. | 1921 | | 1922 | | Percentage of increase or decrease. | |
|---|---|---|---|---|---|---|
| | Gross tons. | Value. | Gross tons. | Value. | Quantity. | Value. |
| Alabama | 2,835,761 | $5,058,161 | 5,294,520 | $8,791,069 | +87 | +74 |
| California | 2,064 | 15,364 | 3,204 | 18,868 | +55 | +23 |
| Colorado | 3,823 | (a) | 513 | (a) | −87 | |
| Georgia | 3,822 | 13,678 | 28,566 | 77,636 | +647 | +468 |
| Idaho | 799 | (a) | 25 | (a) | −97 | |
| Maryland | 1,580 | (a) | | | −100 | −100 |
| Massachusetts | 1,262 | (a) | 4,368 | (a) | +246 | |
| Michigan | 5,011,804 | 18,481,225 | 12,457,856 | 43,449,513 | +149 | +135 |
| Minnesota | 17,648,603 | 62,780,754 | 30,209,372 | 98,903,398 | +71 | +58 |
| Missouri | 36,431 | (a) | 58,320 | 244,928 | +60 | |
| Montana | 26,174 | 91,729 | 21,726 | 59,566 | −17 | −35 |
| Nevada | | | 25 | (a) | | |
| New Jersey | 115,132 | 551,688 | 90,374 | 400,356 | −22 | −27 |
| New Mexico | 110,528 | 244,284 | 118,038 | (a) | +7 | |
| New York | 174,368 | 946,366 | 191,195 | 1,049,050 | +10 | +11 |
| North Carolina | 383 | (a) | 19,279 | 49,415 | +4,934 | |
| Pennsylvania | 187,062 | 288,955 | 782,916 | 1,022,756 | +319 | +254 |
| Tennessee | 25,219 | 68,726 | 159,473 | 418,578 | +532 | +509 |
| Texas | 131 | (a) | | | −100 | −100 |
| Utah | 60,773 | 156,865 | 15,018 | 63,806 | −75 | −59 |
| Virginia | 54,353 | 196,935 | 30,359 | 120,685 | −44 | −39 |
| Wisconsin | 117,755 | 300,954 | 794,673 | 2,455,660 | +575 | +716 |
| Wyoming | 234,701 | (a) | 332,800 | (a) | +42 | |
| Undistributed | | b 549,624 | | b 684,002 | | |
| | 26,652,528 | 89,745,308 | 50,612,620 | 157,809,286 | +90 | +76 |

a Included under "Undistributed."
b This figure includes value for States entered as "(a)" above.

The Lake Superior district, comprising Minnesota, Michigan, and northern Wisconsin, mined about 84 per cent of the total ore in 1922, and the Birmingham district, in Alabama, mined a little less than 10 per cent of the total. The Adirondack district, in New York, contributed less than 1 per cent of the total and was the only district to record a decrease.

*Iron ore mined in the United States, by mining districts and varieties, in 1921 and 1922, in gross tons.*

[Exclusive of ore containing 5 per cent or more of manganese.]

| District. | Hematite. | Brown ore. | Magnetite. | Carbonate. | Total. | Percentage of increase or decrease in 1922. |
|---|---|---|---|---|---|---|
| **1921.** | | | | | | |
| Lake Superior[a] | 25,298,485 | | | | 25,298,485 | |
| Birmingham | 2,548,349 | 180,124 | | | 2,728,473 | |
| Chattanooga | 110,096 | 54,799 | | | 164,895 | |
| Adirondack | | | 446,619 | | 446,619 | |
| Northern New Jersey and southeastern New York | | | 79,513 | | 79,513 | |
| Other districts | [b] [c] 380,319 | [c] 135,231 | [b] 254,734 | 2,709 | 772,993 | |
| | [b] [c] 28,337,249 | [c] 370,154 | [b] 780,866 | 2,709 | 29,490,978 | |
| **1922.** | | | | | | |
| Lake Superior[a] | 39,693,966 | | 22,050 | | 39,716,016 | +57 |
| Birmingham | 4,429,170 | 282,230 | | | 4,711,400 | +73 |
| Chattanooga | 250,083 | 122,121 | | | 372,204 | +126 |
| Adirondack | | | 406,342 | | 406,342 | −9 |
| Northern New Jersey and southeastern New York | | | 113,629 | | 113,629 | +43 |
| Other districts | [c] 515,504 | [c] 379,231 | 910,945 | 3,256 | 1,808,936 | +134 |
| | [c] 44,888,723 | [c] 783,582 | 1,452,966 | 3,256 | 47,128,527 | +60 |

[a] Includes only those mines in Wisconsin which are in the true Lake Superior district.
[b] Some magnetite included with hematite.
[c] Some hematite included with brown ore.

## TOTAL OUTPUT OF IRON ORE.

The following table shows the production of iron ore in the United States as far as it has been recorded or estimated. The figures for the years prior to 1880 are not strictly accurate, having been calculated from the pig iron produced, which included imported ore as well as domestic ore. Details for years 1880 to 1916 will be found in Mineral Resources for 1916.

*Iron ore mined in the United States, 1810–1922, in gross tons.*

[Exclusive after 1905 of ore containing 5 per cent or more of manganese.]

| Year. | Hematite. | Brown ore. | Magnetite. | Carbonate. | Total. |
|---|---|---|---|---|---|
| 1810–1869 | | | | | 49,656,000 |
| 1870–1880 | | | | | 51,690,889 |
| 1881–1890 | | | | | 103,854,386 |
| 1891–1900 | 136,961,046 | 22,845,764 | 14,634,364 | 1,065,137 | 175,506,311 |
| 1901–1910 | 364,179,432 | [b] 28,287,994 | [b] 20,664,453 | 262,366 | 413,394,245 |
| 1911–1915 | 239,419,251 | 8,355,102 | 10,156,539 | 42,495 | 257,973,387 |
| 1916 | 70,728,024 | 1,904,484 | 2,533,364 | 1,800 | 75,167,672 |
| 1917 | 70,743,513 | 1,992,332 | 2,553,006 | | 75,288,851 |
| 1918 | 65,894,709 | 1,613,844 | 2,149,725 | | 69,658,278 |
| 1919 | [c] 57,719,582 | 1,127,397 | [c] 2,118,439 | | 60,965,418 |
| 1920 | [c] [d] 63,883,523 | [d] 1,325,661 | [c] 2,391,541 | 3,740 | 67,604,465 |
| 1921 | [c] [d] 28,337,249 | [d] 370,154 | [c] 780,866 | 2,709 | 29,490,978 |
| 1922 | [d] 44,888,723 | [d] 783,582 | 1,452,966 | 3,256 | 47,128,527 |
| | | | | | 1,477,379,407 |

[a] Includes ore produced by owners of blast furnaces, estimated by census at 800,000 tons.
[b] Some brown ore included with magnetite.
[c] Some magnetite included with hematite.
[d] Some hematite included with brown ore

## PRINCIPAL IRON-ORE MINES.

In 1922 there were 293 iron-ore mines active, compared with 256 in 1921 and 403 in 1920; 109 mines produced more than 100,000 gross tons of iron ore each, compared with 65 in 1921 and 160 in 1920. Of these 109 mines 7 (5 in Minnesota, 1 in Alabama, and 1 in Michigan) produced more than 1,000,000 tons each, as against 5 (3 in Minnesota, 1 in Alabama, and 1 in Michigan) in 1921 and 9 (6 in Minnesota, 2 in Michigan, and 1 in Alabama) in 1920. Permission has been granted to the Geological Survey by the operators of these large mines to publish their production, and these statistics are given in the following table. The trend toward large mining units is shown in the production of nearly 90 per cent of the output of the country by the 109 mines that yielded more than 100,000 tons each.

*Iron-ore mines of the United States that produced more than 100,000 gross tons each in 1922.*

| Rank. | Name of mine. | State. | Nearest town. | Variety of ore. | Gross tons. |
|---|---|---|---|---|---|
| 1 | Hull-Rust | Minnesota | Hibbing | Hematite | 4,474,415 |
| 2 | Missabe Mountain | do | Virginia | do | 3,174,479 |
| 3 | Red Mountain group. | Alabama | Bessemer | do | 2,474,125 |
| 4 | Spruce | Minnesota | Eveleth | do | 1,227,567 |
| 5 | Norrie group | Michigan | Ironwood | do | 1,139,031 |
| 6 | Canisteo | Minnesota | Coleraine | do | 1,120,776 |
| 7 | Mahoning | do | Hibbing | do | 1,024,695 |
| 8 | Woodward Nos. 1, 2, and 3. | Alabama | Woodward | do | 922,829 |
| 9 | Sweeney | Minnesota | Hibbing | do | 874,336 |
| 10 | Hill Annex | do | Calumet | do | 758,162 |
| 11 | Dunwoody | do | Hibbing | do | 690,929 |
| 12 | Cornwall | Pennsylvania | Miners Village | Magnetite | 643,299 |
| 13 | Bennett | Minnesota | Keewatin | Hematite | 638,237 |
| 14 | Holman | do | Taconite | do | 622,207 |
| 15 | Plymouth | Michigan | Verona | do | 607,876 |
| 16 | Pioneer | Minnesota | Ely | do | 604,551 |
| 17 | St. James | do | Aurora | do | 603,330 |
| 18 | Leonidas | do | Eveleth | do | 596,588 |
| 19 | Kerr | do | Hibbing | do | 559,017 |
| 20 | Morris | do | do | do | 525,581 |
| 21 | Newport (including Bonnie). | Michigan | Ironwood | do | 495,207 |
| 22 | Susquehanna | Minnesota | Hibbing | do | 473,818 |
| 23 | Adams | do | Eveleth | do | 468,263 |
| 24 | Wakefield | Michigan | Wakefield | do | 430,136 |
| 25 | Glen | Minnesota | Chisholm | do | 427,058 |
| 26 | North Harrison | do | Nashwauk | do | 422,114 |
| 27 | Dean | do | Buhl | do | 410,751 |
| 28 | Chapin (including Millie). | Michigan | Iron Mountain | do | 380,076 |
| 29 | Chisholm | Minnesota | Chisholm | do | 371,384 |
| 30 | Hawkins | do | Nashwauk | do | 359,938 |
| 31 | Hill-Trumbull | do | Marble | do | 350,015 |
| 32 | Raimund Nos. 1 and 2. | Alabama | Bessemer | do | 344,293 |
| 33 | Miller | Minnesota | Aurora | do | 338,283 |
| 34 | Sunrise | Wyoming | Sunrise | do | 332,800 |
| 35 | Palms | Michigan | Bessemer | do | 321,719 |
| 36 | Fayal | Minnesota | Eveleth | do | 311,502 |
| 37 | Leonard | do | Chisholm | do | 309,652 |
| 38 | Biwabik (including Cincinnati). | do | Biwabik | do | 303,393 |
| 39 | Negaunee | Michigan | Negaunee | do | 299,051 |
| 40 | Armour No. 2 | Minnesota | Crosby | do | 296,208 |
| 41 | Kinney | do | Kinney | do | 292,893 |
| 42 | Montreal | Wisconsin | Hamilton | do | 280,018 |
| 43 | Corsica | Minnesota | McKinley | do | 268,713 |
| 44 | Boeing | do | Hibbing | do | 268,311 |
| 45 | Sloss Nos. 1 and 2 | Alabama | Bessemer | do | 253,565 |
| 46 | Baltic (including Fogarty and Buck). | Michigan | Palatka | do | 252,889 |
| 47 | Danube | Minnesota | Bovey | do | 251,265 |
| 48 | Ironton | Michigan | Bessemer | do | 239,700 |
| 49 | Lake Superior | do | Ishpeming | do | 237,183 |
| 50 | Hobart | Minnesota | Gilbert | do | 222,950 |
| 51 | Morris-Lloyd | Michigan | Ishpeming | do | 221,979 |
| 52 | Patrick | Minnesota | Nashwauk | do | 218,901 |

*Iron-ore mines of the United States that produced more than 100,000 gross tons each in 1922*—Continued.

| Rank. | Name of mine. | State. | Nearest town. | Variety of ore. | Gross tons. |
|---|---|---|---|---|---|
| 53 | Holmes | Michigan | Ishpeming | Hematite | 218,066 |
| 54 | Maas | do | Negaunee | do | 216,600 |
| 55 | Zenith | Minnesota | Ely | do | 214,466 |
| 56 | Stephenson | Michigan | Gwinn | do | 213,223 |
| 57 | Songo | Alabama | Bessemer | do | 213,121 |
| 58 | Harold | Minnesota | Stuntz | do | 212,332 |
| 59 | Tilden | Michigan | Bessemer | do | 210,735 |
| 60 | Aragon | do | Norway | do | 209,796 |
| 61 | Eureka | do | Ramsay | do | 208,799 |
| 62 | Yale | do | Bessemer | do | 204,063 |
| 63 | Utica | Minnesota | Hibbing | do | 196,383 |
| 64 | Albany | do | do | do | 196,345 |
| 65 | Laura | do | do | do | 194,183 |
| 66 | Athens | Michigan | Negaunee | do | 193,259 |
| 67 | Penn group | do | Norway and Vulcan | do | 184,943 |
| 68 | Russellville | Alabama | Russellville | Brown ore | 176,728 |
| 69 | Mary Charlotte | Michigan | Negaunee | Hematite | 175,590 |
| 70 | Arcturus | Minnesota | Marble | do | 173,297 |
| 71 | South Judd | do | Taconite | do | 171,034 |
| 72 | Carpenter | Michigan | Crystal Falls | do | 165,012 |
| 73 | Richmond | do | Palmer | do | 155,518 |
| 74 | Rogers | do | Iron River | do | 152,438 |
| 75 | Harmony | New York | Mineville | Magnetite | 150,947 |
| 76 | Fay | Minnesota | Virginia | Hematite | 149,912 |
| 77 | Marocco | do | Ironton | do | 145,420 |
| 78 | Osana-Wauseca | Michigan | Iron River | do | 141,973 |
| 79 | North Anvil | do | Bessemer | do | 141,344 |
| 80 | Riverton group | do | Iron River | do | 140,382 |
| 81 | Kennedy | Minnesota | Cuyuna | do | 137,270 |
| 82 | Wanless | do | Buhl | do | 136,797 |
| 83 | Bengal | Michigan | Stambaugh | do | 136,665 |
| 84 | Burt | Minnesota | Hibbing | do | 132,550 |
| 85 | Cliffs Shaft | Michigan | Ishpeming | do | 131,502 |
| 86 | Clark | Minnesota | Chisholm | do | 130,571 |
| 87 | Leetonia | do | Hibbing | do | 127,850 |
| 88 | Tobin | Michigan | Crystal Falls | do | 127,100 |
| 89 | Pennington | Minnesota | Ironton | do | 126,713 |
| 90 | Shannon | Alabama | Birmingham | do | 124,916 |
| 91 | Attalla No. 1 | do | Attalla | do | 123,594 |
| 92 | Caspian | Michigan | Caspian | do | 121,858 |
| 93 | Webb | Minnesota | Hibbing | do | 119,441 |
| 94 | Davidson No. 1 | Michigan | Iron River | do | 118,927 |
| 95 | Imperial | do | Michigamme | do | 118,893 |
| 96 | Thorne | Minnesota | Buhl | do | 118,547 |
| 97 | Genoa | do | Gilbert | do | 118,521 |
| 98 | Berkshire | Michigan | Stambaugh | do | 116,265 |
| 99 | Ottawa | Wisconsin | Hamilton | do | 115,509 |
| 100 | Bates | Michigan | Iron River | do | 110,430 |
| 101 | Warren | do | do | do | 110,066 |
| 102 | Rolling Mill | do | Negaunee | do | 109,975 |
| 103 | Hiawatha | do | Iron River | do | 107,018 |
| 104 | Judson | do | Alpha | do | 104,738 |
| 105 | Homer | do | Iron River | do | 103,000 |
| 106 | Shenango | Minnesota | Chisholm | do | 102,562 |
| 107 | Odgers | Michigan | Crystal Falls | do | 102,500 |
| 108 | Majorca | Minnesota | Gilbert | do | 100,861 |
| 109 | Hillcrest | do | Ironton | do | 100,171 |
| | Total (109 mines) | | | | 42,296,777 |
| | Output of 36 mines producing between 50,000 and 100,000 gross tons each | | | | 2,784,221 |
| | Output of 148 mines producing less than 50,000 gross tons each | | | | 2,047,529 |
| | Grand total of United States (293 mines) | | | | 47,128,527 |

## STOCKS OF IRON ORE AT MINES.

According to the reports of producers the total quantity of iron ore in stock at the mines at the end of 1922 amounted to 10,524,279 gross tons, compared with 13,836,267 tons at the end of 1921, a decrease of 24 per cent. As the quantity of ore in stock piles is of necessity partly estimated, there are variations in the mine reports from year to year which prevent an absolute balance between the quantity mined, the quantity shipped, and the stocks on hand. The stocks at the end of 1922 were about 1,000,000 tons below the average for the preceding five years.

*Stock of iron ore at mines, by States, December 31, 1921 and 1922, in gross tons.*

| State. | 1921 | 1922 | State. | 1921 | 1922 |
|---|---|---|---|---|---|
| Alabama | 503,721 | 443,779 | New York | 446,879 | 683,223 |
| Georgia | 4,610 | 120 | North Carolina | 2,200 | ..... |
| Idaho | ..... | 175 | Pennsylvania | 8,405 | 3,069 |
| Iowa | 12,165 | 12,165 | Tennessee | 3,709 | ..... |
| Massachusetts | 4,368 | ..... | Virginia | 62,298 | 62,441 |
| Michigan | 7,879,344 | 6,061,403 | Wisconsin | 460,161 | 297,628 |
| Minnesota | 4,234,952 | 2,750,916 | | 13,836,267 | 10,524,279 |
| Missouri | 4,798 | 5,280 | | | |
| New Jersey | 208,657 | 204,080 | | | |

## PRICES OF IRON ORE PER TON.

In the following table the average selling price at the mines of the different classes of iron ore in 1921 and 1922 is given for each of the producing States or group of States, except where there were less than three producers or shippers of a certain variety of ore in a State and permission was not given to publish the prices. These figures are taken directly from statements of the producers and probably represent the selling prices only approximately, as all the reports are not consistent; some of them evidently include merely mining costs; others contain, in addition, the cost of selling and insuring the ore; in others an allowance for sinking fund is included; and in still others the figures given are the costs charged against the blast furnaces. None of the reports, however, are supposed to include cost of freight.

The second following table summarizes the average prices of iron ore at mines beginning with 1911. Not until 1917 did the average price rise above $3 a ton, and the average for 1922, $3.12, is the lowest since 1916.

*Average price per gross ton of iron ore at mines in the United States in 1921 and 1922.*

| State. | Hematite. | | Brown ore. | | Magnetite. | |
|---|---|---|---|---|---|---|
| | 1921 | 1922 | 1921 | 1922 | 1921 | 1922 |
| Alabama | $1.72 | $1.54 | $2.50 | $2.55 | ..... | ..... |
| California | ..... | ..... | ..... | ..... | $7.44 | $5.89 |
| Georgia | ..... | (a) | 3.58 | 2.71 | ..... | ..... |
| Michigan | 3.69 | 3.49 | ..... | ..... | ..... | ..... |
| Minnesota | 3.56 | 3.27 | ..... | ..... | ..... | (a) |
| Missouri | (a) | 4.22 | ..... | 3.35 | ..... | ..... |
| Montana | (a) | (b) | 4.88 | b 2.74 | 3.41 | ..... |
| New Jersey | ..... | ..... | (a) | ..... | 4.75 | 4.43 |
| New Mexico | 2.23 | ..... | ..... | ..... | (a) | (a) |
| New York | ..... | ..... | ..... | ..... | 5.43 | 5.49 |
| North Carolina | ..... | ..... | (a) | 2.27 | ..... | (a) |
| Pennsylvania | ..... | ..... | (a) | (a) | 1.51 | 1.30 |
| Tennessee | (a) | (a) | (a) | 2.77 | ..... | ..... |
| Virginia | (a) | (a) | 3.57 | 3.98 | ..... | ..... |
| Wisconsin | 2.56 | 3.09 | ..... | ..... | ..... | (a) |
| Other States c | 1.94 | 1.26 | 1.75 | 3.74 | 5.04 | 2.25 |
| | 3.37 | 3.14 | 2.63 | 2.65 | 3.61 | 2.37 |

a Less than three producers and permission to publish not given, therefore price may not be shown.
b Value for hematite included with brown ore.
c 1921: Colorado, Idaho, Maryland, Massachusetts, Missouri, North Carolina, Tennessee, Texas, Utah, and Wyoming; 1922: Colorado, Idaho, Massachusetts, Nevada, New Mexico, Utah, and Wyoming.

*Average price per gross ton of iron ore in the United States, 1911–1922.*

| Year. | Hematite. | Brown ore. | Magnetite. | Carbonate. | General average.[a] |
|---|---|---|---|---|---|
| 1911 | $2.12 | $1.72 | $2.29 | $1.83 | $2.11 |
| 1912 | 1.87 | 1.79 | 2.18 | 1.96 | 1.88 |
| 1913 | 2.21 | 1.88 | 2.07 | 2.06 | 2.19 |
| 1914 | 1.79 | 1.72 | 2.39 | 2.44 | 1.81 |
| 1915 | 1.80 | 1.80 | 2.50 | 2.44 | 1.83 |
| 1916 | 2.32 | 2.03 | 3.11 | 3.00 | 2.24 |
| 1917 | 3.12 | 2.95 | 4.29 | ..... | 3.15 |
| 1918 | 3.35 | 3.51 | 4.60 | ..... | 3.39 |
| 1919 | 3.48 | 3.63 | 4.08 | ..... | 3.50 |
| 1920 | 4.09 | 4.19 | 4.59 | (b) | 4.11 |
| 1921 | 3.37 | 2.63 | 3.61 | (b) | 3.37 |
| 1922 | 3.14 | 2.65 | 2.37 | (b) | 3.12 |

[a] Average prices in 1879 and 1892–1910 are given in Mineral Resources for 1919 and many earlier volumes.
[b] Sold for paint and not included in shipments of iron ore.

## LAKE SUPERIOR DISTRICT.

### PRODUCTION.

The total quantity of ore mined in the Lake Superior district, not including the Iron Ridge area in Wisconsin, increased 57 per cent in 1922. The output of the several ranges is shown below. After 1905 all manganiferous iron ore containing more than 5 per cent of manganese is excluded; the production of this class amounted to 566,157 gross tons in 1922. The Mesabi range produced 67 per cent of the output of the Lake Superior district and 57 per cent of the output of the United States in 1922. The proportion from this range has been maintained with remarkable uniformity since 1915 and was slightly above the average in 1922. There were increases in production in all the iron ranges, but that of the Cuyuna showed the greatest rise, which was due to an abnormally low output in 1921.

*Iron ore mined in the Lake Superior district, 1854–1922, in gross tons.*

[Exclusive after 1905 of ore containing 5 per cent or more of manganese.]

| Year. | Marquette. | Menominee. | Gogebic. | Vermilion. | Mesabi. | Cuyuna. | Total. |
|---|---|---|---|---|---|---|---|
| 1854–1870 | 3,971,716 | ..... | ..... | ..... | ..... | ..... | 3,971,716 |
| 1871–1880 | 10,294,047 | 858,810 | ..... | ..... | ..... | ..... | 11,152,857 |
| 1881–1890 | 18,598,012 | 11,917,416 | 8,657,807 | 3,260,426 | ..... | ..... | 42,433,661 |
| 1891–1900 | 27,269,545 | 21,639,872 | 23,361,043 | 12,097,048 | 32,282,873 | ..... | 116,650,381 |
| 1901–1910 | 37,728,143 | 41,974,789 | 34,514,899 | 15,350,581 | 194,654,902 | ..... | 324,223,314 |
| 1911–1915 | 18,404,620 | 21,862,454 | 21,366,821 | 7,234,387 | 142,721,213 | 3,191,627 | 214,781,122 |
| 1916 | 4,792,987 | 6,649,578 | 7,707,101 | 1,704,440 | 41,325,341 | 1,555,641 | 63,735,088 |
| 1917 | 4,638,374 | 6,366,483 | 7,881,232 | 1,481,301 | 41,127,323 | 1,986,608 | 63,481,321 |
| 1918 | 3,946,554 | 6,041,637 | 7,837,634 | 1,192,677 | 39,055,977 | 1,705,315 | 59,779,794 |
| 1919 | 4,158,751 | 4,863,968 | 7,368,994 | 1,051,795 | 33,262,954 | 1,685,877 | 52,392,339 |
| 1920 | 4,457,609 | 5,651,542 | 8,298,206 | 1,053,518 | 36,641,880 | 1,757,775 | 57,860,530 |
| 1921 | 2,204,114 | 2,147,569 | 3,135,477 | 981,576 | 16,380,190 | 449,559 | 25,298,485 |
| 1922 | 2,745,626 | 3,290,641 | 4,910,789 | 1,108,764 | 26,704,601 | 955,595 | 39,716,016 |
| | 143,210,098 | 133,264,759 | 135,040,003 | 46,516,513 | 604,157,254 | 13,287,997 | 1,075,476,624 |

### SHIPMENTS AND RECEIPTS.

According to the Iron Trade Review, 43,990,096 gross tons of iron ore and manganiferous iron ore was shipped in 1922 from the Lake Superior district, including the Iron Ridge and Baraboo areas in Wisconsin, as compared with 22,798,349 tons in 1921. The shipments as reported to the Geological Survey amounted to 43,461,901

gross tons, exclusive of 566,157 gross tons of manganiferous iron ore containing 5 per cent or more of manganese, compared with 22,778,162 tons of iron ore and 56,581 tons of manganiferous iron ore in 1921.

The iron ore received at Lake Erie ports amounted to 32,518,784 gross tons and at Lake Michigan ports to 9,089,457 gross tons, a total of 41,608,241 tons, compared with 15,830,457 tons at Lake Erie ports and 5,838,678 tons at Lake Michigan ports, a total of 21,669,135 tons, in 1921. Detailed figures of shipments and receipts by ports and by months for recent years will be found in the Iron Trade Review and, for 1919 and preceding years, in Mineral Resources.

### STOCKS OF IRON ORE AT LAKE ERIE PORTS.

Stocks of iron ore at lower Lake ports at the end of the shipping season are of importance on account of their bearing on the manufacture of pig iron during the following winter and spring. At the close of navigation in 1922 there was 10,635,908 gross tons of ore in stock at Lake Erie ports, compared with 9,096,909 tons at the corresponding date in 1921.[2] At the opening of navigation in May, 1923, there was 4,857,542 gross tons of ore in stock at these ports,[3] indicating a withdrawal of nearly 5,800,000 tons during the winter of 1922–23. The average quantity withdrawn each winter during the preceding five winters was nearly 3,733,000 tons. Detailed statistics concerning these stocks by ports will be found in the Iron Trade Review and Marine Review and, for 1919 and preceding years, in Mineral Resources.

### PRICES OF LAKE SUPERIOR IRON ORE.

The value of iron ore per unit of iron, in the natural state, for the four standard grades of Lake Superior ore for the last 23 years is shown in the Iron Trade Review.[4] The base of old range and Mesabi Bessemer ore is a metallic iron content of 55 per cent, natural, and for the old range and Mesabi non-Bessemer 51.5 per cent, natural. The values established June 9, 1922, are as follows: Old range Bessemer, 11.909 cents; Mesabi Bessemer, 11.454 cents; old range non-Bessemer, 11.262 cents; Mesabi non-Bessemer, 10.971 cents. The prices per ton that correspond to these unit prices are, respectively, $5.95, $5.70, $5.20, and $5.05 and are 50 cents lower than the prices prevailing during the shipping season of 1921 and $1.50 lower than the prices in 1920. The prices in 1920 were the highest on record. The lowest prices ever quoted for these ores were $2.60 for old range Bessemer in 1897, $2.15 for Mesabi Bessemer in 1895, $1.85 for old range non-Bessemer in 1898, and $1.75 for Mesabi non-Bessemer ore in 1898.

## MINING DEVELOPMENTS.

### LAKE SUPERIOR DISTRICT.[5]

*Mesabi range.*—The activity in mining on the Mesabi range is shown by the increase in production of 63 per cent. The production amounted to about 82 per cent of the average for the preceding

[2] Iron Trade Review.
[3] Marine Review.
[4] Iron Trade Review, June 15, 1922, p. 1743.
[5] More extended reviews will be found in the technical press. See Iron Age, Jan. 4, 1923; Iron Trade Review, Jan. 4, 1923; Eng. and Min. Jour.-Press, Jan. 20, 1923; Skillings' Min. Rev., Nov. 18, 1922, Jan. 13, 1923, and Feb. 10, 1923.

10 years. Notwithstanding the increased mining activity exploration does not seem to have been pushed vigorously, and the new ore discovered during the year was not sufficient to keep pace with production. Near certain of the mines drilling was done in order to prove the existence of ore already believed to be present, and there were several stripping operations and a few shafts being sunk. Shipments of ore were made from the new Boeing, Bradford, South Judd, and Tyler mines. High wages and scarcity of laborers are causing greater efforts to perfect larger equipment and more labor-saving devices for mining, handling, and transporting ore. A new steam shovel with three caterpillar tractors has been developed. Ore cars with a capacity of 100 tons each have been built. Gasoline locomotives are in use underground. In order to keep the grade of ore up to requirements and to extend the life of the ore deposits, advances continue in beneficiation methods through washing of the sandy ore of the western part of the Mesabi range and magnetic concentration of the ore at the east end of the range. The first commercial shipments of sintered magnetic concentrates were made from the plant of the Mesabi Iron Co. at Babbitt in 1922. The Ford Motor Co. is reported to be using the ore, and it is expected that shipments can be continued by rail throughout the winter, for the ore, being moisture free, does not freeze, and as it is a low-phosphorus ore it commands a higher price and can stand the higher cost of all-rail haul. The Bethlehem Steel Corporation interests, through purchase of the Midvale Steel Co., have acquired a share in the Mesabi Iron Co. and in other large mines on the Mesabi range and through purchase of the Lackawanna Steel Co. holdings in several additional mines on this range.

*Vermilion range.*—Mines on the Vermilion range had a busy season in 1922 and increased their production about 13 per cent; the output was about 83 per cent of the average for the preceding 10 years. Exploration apparently added a little more ore to reserves than was mined during the year. As the mines on the Vermilion range are underground, the mechanical developments consisted chiefly in improvements to mining machinery, hoisting, shaft sinking, and the development and utilization of hydroelectric power. A new power plant under construction at Fall Lake will supply power not only to mines on the Vermilion range but also to the Mesabi range. Some labor shortage during the summer was ascribed to extensive road building in Minnesota. A subsidiary of the Bethlehem Steel Corporation acquired an interest in the Zenith mine through purchase of the Midvale Steel Co.

*Cuyuna range.*—During the first four months of 1922 there was very little activity on the Cuyuna range, but with the opening of navigation the demand for ore stimulated mining on this range to such an extent that production increased 198 per cent over that of 1921. A large part of this output was manganiferous ore (553,653 tons was reported to the Survey as containing 5 per cent or more of manganese). The production of iron ore containing less than 5 per cent of manganese increased 113 per cent, and the output was about 79 per cent of the average for the 10 preceding years. New installations and reconstruction of beneficiating equipment, chiefly for washing and drying ore, were features of the year's developments. Explorations

were not very active, but substantial quantities of high-grade ore were discovered on certain properties, and the total reserve as estimated showed an increase. Here, as in the other ranges, the year closed with a slight shortage of mine labor, made evident, no doubt, because an unusual amount of winter work seemed warranted by the favorable outlook of 1923. The Huntington mine made its initial shipment of ore.

*Gogebic range.*—As in the Cuyuna range, conditions in the Gogebic range at the beginning of 1922 were very quiet, and some mines were being operated in order to give employment to needy miners, but within a period of six months all the mines were shipping, and by midsummer a shortage of labor had developed. This labor shortage, it should be noted, was not due wholly to excessive demand for labor in the mines but in part to greater attractions offered by other employment, such as work in automobile factories and rumors of higher wages in western mining districts. In the summer it is difficult to hold some of the younger miners, who prefer outdoor work to underground mining. The production increased about 57 per cent and was about 81 per cent of the average for the preceding 10 years. In the Michigan portion of the range the estimated ore reserves showed a decrease of more than 4,000,000 tons, but not quite as much as was produced during 1922.

Among the important phases of work necessitated by the revival in mining were stripping, shaft sinking and relining, exploratory drilling, track grading, and installation of electric hoists. Extensive construction projects were under way at several mines with the object not only of housing the miners and their families, but also of making living conditions as attractive as possible, club houses being included in the plans and landscape features being given attention. A magnetic separator was built at the Berkshire mine, near Mellen, Wis., which began shipping the product to the Charcoal Iron Co.'s furnace at Ashland, Wis. The Minnewawa mine made its initial shipment of ore. The Bethlehem Steel Corporation acquired an interest in the Plymouth mine through purchase of the Midvale Steel Co.

*Marquette range.*—The production of ore on the Marquette range, though not as great as during war years, increased about 25 per cent and was about 71 per cent of the average for the preceding 10 years. Estimated ore reserves showed a decrease of only about 851,000 tons at the end of 1922, thus indicating that new discoveries nearly kept pace with production. Active explorations were in progress during the year at several places on the Marquette range, at some of them by the Bethlehem Steel Corporation or its subsidiaries, which acquired interests in this area through the Lackawanna purchase, and at others by the Ford Motor Co., which made shipments from the Imperial mine. An underground loader has been developed at the mines of the Cleveland-Cliffs Iron Co. for use with 1-ton dump cars, which, it is claimed, shows an increase in the quantity of ore a man is able to load and consequently will increase wages of miners where it can be used. It may prove to be of use in coal mining also.

*Menominee range.*—The production of ore on the Menominee range increased about 53 per cent and was about 66 per cent of the average for the preceding 10 years. The Cardiff and West Chapin mines made

their first shipments in 1922. In the Michigan portion of the range the estimated reserves of ore increased more than 2,000,000 tons, evidently as a result of more active exploration than during the previous year. An interest in the Penn mine was obtained by Bethlehem through purchase of Midvale.

*Iron-ore reserves.*—Estimates of ore reserves for Minnesota, furnished by the Minnesota Tax Commission, and for Michigan, furnished by the Michigan Board of State Tax Commissioners, including developed and prospective ore in the ground and ore in stock piles, show a decrease of nearly 14,800,000 gross tons in Minnesota and nearly 3,000,000 in Michigan. The Vermilion and Cuyuna ranges in Minnesota and the Menominee range in Michigan each showed increases in 1922.

*Iron-ore reserves in Minnesota May 1, 1919–1922, in gross tons.*

| Range. | 1919 | 1920 | 1921 | 1922 |
|---|---|---|---|---|
| Mesabi | 1,328,821,214 | 1,305,926,735 | 1,273,128,664 | 1,252,820,242 |
| Vermilion | 11,621,197 | 10,927,844 | 13,201,525 | 14,354,328 |
| Cuyuna | 59,393,443 | 24,819,959 | 25,080,590 | 29,485,159 |
| | 1,399,835,854 | 1,341,674,538 | 1,311,410,779 | 1,296,659,729 |

*Iron-ore reserves in Michigan Jan. 1, 1920–1923, in gross tons.*

| Range. | 1920 | 1921 | 1922 | 1923 |
|---|---|---|---|---|
| Gogebic | 64,563,003 | 64,964,666 | 62,405,146 | 58,314,512 |
| Marquette | 70,114,034 | 73,853,786 | 72,953,551 | 72,102,521 |
| Menominee (including Iron River and Crystal Falls districts) | 63,929,438 | 65,311,868 | 64,386,025 | 66,409,915 |
| | 198,606,475 | 204,130,320 | 199,744,722 | 196,826,948 |

## SOUTHEASTERN STATES.

The revival in iron-ore mining in Birmingham, Chattanooga, and other districts in Alabama, Tennessee, North Carolina, and Georgia is shown in increases ranging between 74 and 127 per cent. No important changes in mining or discoveries of ore have been reported from any of these areas. Of interest in prospecting and mining are the publication by the Geological Survey of bulletins on magnetic ores in North Carolina and east Tennessee and on brown ore in North Carolina (for titles see p. 343) and the continuation of field and laboratory studies begun by the Bureau of Mines in 1921 on iron ores and on mining and concentration of these deposits. Among these special studies was the use of the dip needle in magnetometric prospecting for deposits of brown ores. Studies of concentration of both brown and red ores are being carried on, and that of the high-silica red ores will be of particular value in view of the large quantity of lean ores closely associated with the beds of ore of present workable grade in the Birmingham district.

NORTHEASTERN STATES.

*Adirondack district.*—The Adirondack district was the only area in the United States to show a decrease in production of iron ore in 1922 as compared with 1921; this decrease was about 9 per cent. The output was singularly small, being only about 49 per cent of the average for the preceding 10 years and less than that for any one of these years. In view of the new interest that is being taken in magnetite ore it appears that this condition should be only temporary. Concentration of the Adirondack magnetite appears to be generally as feasible as that of the eastern Mesabi magnetite, and if the reserves of magnetite in the Adirondacks are as great as is indicated in a recent article by Nason [6] and if freight rates are adjusted equitably the future production of this ore should show a large increase. Nason estimates that within the Crown Point, Mineville, Lyon Mountain, Saranac, Ausable, and Benson areas there is sufficient known nontitaniferous ore to yield 1,500,000 tons of concentrates annually for 32 years, and in addition sufficient prospective nontitaniferous ore to yield 6,250,000 tons of concentrates annually for 100 years. There are also large reserves of titaniferous ore in the Sanford Lake region which may be of value in the future. The three operating companies are considered to be equipped to produce 1,500,000 tons of concentrates yearly, containing 61 to 68 per cent of iron and 0.2 to 0.004 per cent of phosphorus, and could be equipped to produce twice that quantity of ore if it could be marketed. Nason compares the cost of freight per unit of iron and points out that on the basis of freight charge there should be a neutral point between Buffalo and New York City where non-Bessemer Lake ores and Adirondack concentrates would apparently compete on even terms.

The Bethlehem Steel Corporation is reported to have acquired certain interests in deposits of magnetite ore in the Adirondack district through the Lackawanna Steel Co. and in some mines in Orange County, N. Y., through the Midvale Steel Co.

WESTERN STATES.

The iron ore mined in the Western States increased nearly 12 per cent in 1922. The increase was chiefly in the States where iron ore is mined for the manufacture of pig iron, as in Wyoming and New Mexico, but there were decreases in output from States where iron ore is mined for flux in smelting of precious metals, as in Montana, Utah, Idaho, and Nevada. In California an increase was reported in production of magnetite now used in making steel.

Reports from Utah tell of plans for the development of deposits of iron ore in the Iron Springs district. The Los Angeles & Salt Lake Railroad was authorized by the Interstate Commerce Commission to build a branch line from a point near Lund to Cedar City, to open a tract of 840,000 acres. According to the report of the commission,[7]

Two large steel companies contemplate opening mines and shipping ore from this district as soon as the branch line is built. One of these companies proposes to construct blast furnaces for reducing the ore, which will probably be located on Utah

[6] Nason, F. L., Adirondack ores are important: Iron Trade Rev., June 8, 1922, pp. 1651–1653; Iron Age, June 8, 1922, pp. 1592–1593. (Abstracts of paper read before the American Iron and Steel Institute, May 26, 1922.)

[7] Iron Age, Oct. 26, 1922, p. 1085.

Lake. The development of the ore deposits is necessarily contingent upon the construction of the proposed branch. The applicant estimates that initial shipments of iron ore will total 1,250 tons a day and that the output will be substantially increased as the district develops.

A study of these ore deposits has been made by the United States Geological Survey.[8]

## FOREIGN TRADE IN IRON ORE.

### IMPORTS AND EXPORTS.[9]

The iron ore imported into the United States in 1922 increased 259 per cent in quantity and 357 per cent in value, as compared with 1921. The average value was $4.33 a ton in 1922 and $3.41 in 1921.

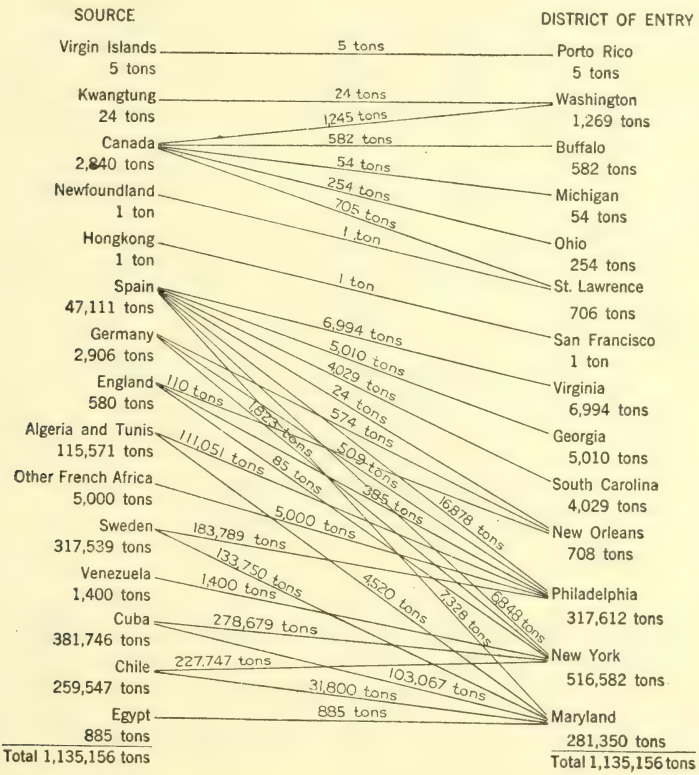


FIGURE 12.—Source and district of entry of iron ore imported into the United States in 1922.

Cuba contributed 34 per cent of the ore imported, Sweden 28 per cent, aud Chile 23 per cent. Shipments of ore from Chile, resumed on a small scale in 1921 after four years of inactivity due to the war, showed the most notable increase in 1922. The accompanying diagram (fig. 12) indicates the source and district of entry of the iron ore imported into the United States.

[8] Leith, C. K., and Harder, E. C., The iron ores of the Iron Springs district, southern Utah: U.S. Geol. Survey Bull. 338, 102 pp., 1908.

[9] The statistics of imports and exports were compiled by J. A. Dorsey, of the United States Geological Survey, from records of the Bureau of Foreign and Domestic Commerce, Department of Commerce.

*Iron ore imported into the United States, 1920–1922.*

| Country. | 1920 | | 1921 | | 1922 | |
|---|---|---|---|---|---|---|
| | Gross tons. | Value. | Gross tons. | Value. | Gross tons. | Value. |
| Algeria and Tunis | 158,879 | $462,222 | 8,336 | $25,304 | 115,571 | $330,182 |
| Other French Africa | | | | | 5,000 | 14,484 |
| Belgium | | | 436 | 1,814 | | |
| British India | 2,812 | 25,133 | | | | |
| Canada | 34,084 | 164,158 | 4,213 | 15,667 | 2,840 | 10,439 |
| Chile | | | 8,000 | 30,000 | 259,547 | 1,625,332 |
| China | 2 | 18 | 417 | 19,169 | | 2 |
| Colombia | 11,649 | 46,596 | | | | |
| Cuba | 889,852 | 3,488,682 | 123,222 | 493,092 | 381,746 | 1,580,504 |
| Egypt | | | 6,000 | 17,922 | 885 | 23,685 |
| France | | | 1,012 | 4,935 | | |
| Germany | 1 | 14 | 744 | 4,023 | 2,906 | 14,709 |
| Hongkong | | | | | 1 | 58 |
| Hungary | 4,380 | 8,710 | | | | |
| Kwangtung | 1 | 21 | 40 | 218 | 24 | 79 |
| Mexico | 124 | 982 | | | | |
| Morocco | 34,950 | 165,246 | 14,360 | 57,912 | | |
| Newfoundland and Labrador | | | | | 1 | 5 |
| Norway | 1,828 | 8,228 | | | | |
| Panama | 802 | 4,532 | | | | |
| Philippine Islands | 1 | [a] 250 | | | | |
| Spain | 69,915 | 241,640 | 5,602 | 17,427 | 47,111 | 242,783 |
| Sweden | 63,861 | 340,519 | 143,234 | 384,283 | 317,539 | 1,054,992 |
| United Kingdom | 315 | 6,703 | 152 | 4,143 | 580 | 13,142 |
| Venezuela | | | | | 1,400 | 5,838 |
| Virgin Islands of the United States | | | | | 5 | 60 |
| | 1,273,456 | 4,963,654 | 315,768 | 1,075,909 | 1,135,156 | 4,916,294 |

[a] Correct as reported by collector of customs, San Francisco, Calif.

*Iron ore imported into the United States, 1872–1922.*

| Year. | Gross tons. | Year | Gross tons. | Year. | Gross tons. |
|---|---|---|---|---|---|
| 1872–1880 | 1,188,267 | 1911–1915 | 9,202,947 | 1919 | 476,461 |
| 1881–1890 | 7,663,630 | 1916 | 1,325,736 | 1920 | 1,273,456 |
| 1891–1900 | 5,869,757 | 1917 | 971,663 | 1921 | 315,768 |
| 1901–1910 | 11,798,568 | 1918 | 787,468 | 1922 | 1,135,156 |
| | | | | | 42,008,877 |

The iron ore exported from the United States in 1922, 602,194 gross tons, was valued at $2,770,878, or $4.60 a ton, compared with 440,106 tons, valued at $2,077,620, or $4.72 a ton, in 1921. The exports represent an increase of 37 per cent in quantity and 33 per cent in value, as compared with 1921. With the exception of 6,281 tons to Mexico and 8 tons to Chile, all the ore exported in 1922 went to Canada.

*Iron ore exported from the United States, 1899–1922, in gross tons.*

| Year. | Quantity. | Year. | Quantity. |
|---|---|---|---|
| 1899–1900 | 92,125 | 1919 | 996,569 |
| 1901–1910 | 2,713,397 | 1920 | 1,145,037 |
| 1911–1915 | 4,265,538 | 1921 | 440,106 |
| 1916 | 1,183,952 | 1922 | 602,194 |
| 1917 | 1,132,313 | | |
| 1918 | 1,256,383 | | 13,827,614 |

## IRON-ORE MINING IN CUBA.

The iron ore shipped from Cuba to the United States in 1922, 444,794 gross tons, was valued at $1,416,098, compared with 130,359 tons, valued at $477,002, in 1921, and showed an increase in quantity of 241 per cent and in value of 197 per cent. The average price of the ore was $3.18 a ton in 1922; in 1921 it was $3.66 a ton. The shipments in 1922 consisted of hematite and a little magnetite from the Daiquiri and Juragua mines, on the southern coast. The Mayari mines, near the northern coast, were nonproductive in 1921 and 1922. In 1922 the iron content of the hematite, dried at 212° F., was reported at 58.58 per cent; in 1921 it averaged 57.37 per cent.

The total stock of ore (natural and nodulized) reported as on hand at the end of 1922 was 965,485 gross tons, compared with 941,939 tons at the end of 1921, an increase of 2 per cent.

The following table shows the shipments of iron ore from Cuba since the opening of the mines in 1884. The statistics of the shipments of Cuban iron ore are collected by the United States Geological Survey:

*Iron ore shipped from mines in the Province of Oriente, Cuba, 1884–1922, in gross tons.*

| Year. | Juragua (hematite and magnetite). | Sigua (hematite). | Daiquiri (hematite and a little magnetite). | Mayari (brown ore). | Guamá (hematite). | El Cuero (hematite). | Total. |
|---|---|---|---|---|---|---|---|
| 1884–1890 | 1,142,519 | ..... | ..... | ..... | ..... | ..... | 1,142,519 |
| 1891–1900 | [a] 2,348,473 | 20,438 | [b] 979,992 | ..... | ..... | ..... | 3,348,903 |
| 1901–1910 | 2,104,186 | ..... | [c] 4,456,440 | 307,700 | 41,241 | 224,729 | 7,134,296 |
| 1911–1915 | 1,567,112 | ..... | 1,837,669 | 1,855,525 | ..... | 532,194 | 5,792,500 |
| 1916 | 212,013 | ..... | 181,602 | 258,451 | ..... | 60,650 | 712,716 |
| 1917 | 39,784 | ..... | 181,028 | 287,904 | ..... | 44,769 | 553,485 |
| 1918 | 17,128 | ..... | 353,103 | 232,540 | ..... | 40,761 | 643,532 |
| 1919 | ..... | ..... | 279,700 | 78,080 | ..... | ..... | 357,780 |
| 1920 | (d) | ..... | [d] 561,268 | 321,515 | ..... | ..... | 882,783 |
| 1921 | (d) | ..... | [d] 130,359 | ..... | ..... | ..... | 130,359 |
| 1922 | (d) | ..... | [d] 444,794 | ..... | ..... | ..... | 444,794 |
| | [d] 7,431,215 | 20,438 | [d] 9,405,955 | 3,341,715 | 41,241 | 903,103 | 21,143,667 |

[a] Of this quantity, 5,932 tons was sent to Pictou, Nova Scotia.
[b] Of this quantity, 51,537 tons was sent to foreign ports.
[c] Of this quantity, 12,691 tons was sent to foreign ports.
[d] Shipments of Juragua mines, 1920–1922, included with Daiquiri mines.

## PRODUCTION OF IRON ORE, BY COUNTRIES.

The following table shows the production of iron ore by countries as far as it has been possible to obtain figures for 1919 to 1922. (For preceding years see earlier volumes of Mineral Resources.)

*Iron ore produced, 1919–1922, by countries, in metric tons.*

| Country. | 1919 | 1920 | 1921 | 1922 | Source of data.[a] |
|---|---|---|---|---|---|
| North America: | | | | | |
| Canada [b] | 178,869 | 117,092 | 53,894 | 5,315 | 1919–1920, 1; 1921–1922, 2. |
| Cuba [b] | 363,522 | 896,952 | 132,451 | 451,933 | 1919–1922, 3. |
| Newfoundland [b] | 453,565 | 590,850 | (c) | (c) | 1919–1920, 1. |
| United States | 61,943,913 | 68,689,517 | 29,964,308 | 47,884,940 | 1919–1922, 3. |
| South America: | | | | | |
| Chile [d] | ..... | ..... | 48,393 | 222,947 | 1919–1922, 4. |
| Europe: | | | | | |
| Austria | 250,491 | 435,062 | 710,932 | 1,112,415 | 1919–1922, 5. |
| Belgium | 4,820 | 17,260 | 38,300 | 63,200 | 1919–1922, 6. |
| Czechoslovakia | 983,416 | 1,053,124 | (c) | (c) | 1919–1920, 7. |
| France | 9,412,786 | 13,921,800 | 14,200,937 | 20,831,993 | 1919–1922, 8. |
| Germany | 6,142,359 | 6,354,344 | (c) | (c) | 1919–1920, 10. |
| Greece | 46,939 | 45,579 | 54,925 | 49,272 | 1919–1922, 11. |
| Hungary | 112,525 | 101,665 | 36,015 | 45,909 | 1919–1920, 12; 1921–1922, 13. |
| Italy | 613,025 | 389,876 | 279,478 | 416,400 | 1919–1922, 14. |
| Luxemburg | 3,112,472 | 3,704,390 | 3,031,626 | 4,448,974 | 1919–1921, 15; 1922, 21. |
| Norway | 89,765 | 79,208 | 54,975 | 268,815 | 1919–1922, 16. |
| Poland | 93,342 | 120,000 | 239,000 | 392,000 | 1919–1921, 17; 1922, 18. |
| Portugal | 8,712 | 12,845 | 10,370 | (c) | 1919–1921, 18a. |
| Rumania [e] | 112,681 | 79,839 | 91,109 | 94,607 | 1919–1922, 19. |
| Russia | (c) | 170,356 | 170,356 | 220,775 | 1920–1922, 20. |
| Spain | 4,640,061 | 4,767,693 | 2,602,369 | 2,771,888 | 1919–1922, 21. |
| Sweden | 4,981,110 | 4,519,112 | 6,464,347 | 6,200,000 | 1919–1921, 22; 1922, 20. |
| United Kingdom | 12,450,875 | 12,910,840 | 3,533,776 | 6,981,845 | 1919, 23; 1920–1922, 24. |
| Yugoslavia | (c) | 1,130 | 15,317 | (c) | 1920–1921, 25. |
| Asia: | | | | | |
| China | 1,338,874 | 1,489,731 | 1,270,000 | (c) | 1919–1921, 26. |
| Chosen | 423,267 | 454,427 | 242,225 | 185,560 | 1919–1920, 27; 1921–1922, 27a. |
| India | 572,798 | 566,961 | 957,204 | (c) | 1919–1921, 28. |
| Indo-China | 5,100 | 2,376 | (c) | (c) | 1919–1920, 8. |
| Japan | 204,846 | 203,559 | 19,935 | (c) | 1919–1921, 29. |
| Unfederated Malay States | ..... | ..... | 75,442 | 113,154 | 1919–1922, 30. |
| Africa: | | | | | |
| Algeria | 738,376 | 1,071,278 | 720,840 | 1,045,816 | 1919, 8; 1920–1922, 31. |
| Belgian Congo | 85,000 | 79,732 | 73,215 | 71,305 | 1919–1922, 32. |
| Morocco | 269,023 | (c) | (c) | (c) | 1919, 33. |
| Rhodesia | 2,268 | ..... | ..... | ..... | 1919–1922, 34. |
| Tunis | 308,135 | 406,280 | 265,736 | 500,000 | 1919, 8; 1920–1921, 35; 1922, 9. |
| Union of South Africa | 3,268 | 2,326 | 2,192 | 1,913 | 1919–1922, 36. |
| Oceania: | | | | | |
| Australia— | | | | | |
| New South Wales [f] | 149,135 | 165,820 | 181,839 | 115,152 | 1919–1922, 37. |
| Queensland | 25,072 | 20,025 | 4,126 | ..... | 1919–1922, 38. |
| South Australia | 272,840 | 419,667 | 515,130 | 52,248 | 1919–1922, 39. |
| Philippine Islands | 18,598 | ..... | (c) | (c) | 1919–1920, 40. |

[a] 1, Canada Dept. Mines, Mines Branch; 2, Dominion Bureau of Statistics; 3, U. S. Geol. Survey; 4, Bethlehem-Chile Iron Mines Co.; 5, Mitteilungen über den Oesterreichischen Bergbau; 6, Statistique des industries extractives et métallurgiques; 7, State Statistical Office; 8, Statistique de l'industrie minérale; 9, L'Écho des mines; 10, Sonderabdruck aus dem Vierteljahrshefte zur Statistik; 11, Tableau statistique du mouvement minier; 12, Bureau of Mines, Ministry of Finance, and American Commission; 13, Royal Hungarian Ministry of Foreign Affairs; 14, Rivista del servizio minerario; 15, American consul general, Rotterdam; 16, Norges offisielle Statistikk; 17, Polish Government through American legation, Warsaw; 18, Commerce Repts., July 2, 1923; 18a, American consul general, Lisbon; 19, Statistique minière de la Roumanie; 20, Commerce Repts.; 21, Estadística minera de España; 22, Sveriges officiella Statistik, Bergshantering; 23, Mines and Quarries (London); 24, Annual report of the Secretary for Mines and H. M. Chief Inspector of Mines; 25, Royal Ministry of Forests and Mines, through American minister; 26, Director of the Geological Survey of China, through the American consul general at Tientsin; 27, American embassy, Tokyo; 27a, American consul, Seoul; 28, Records Geol. Survey of India; 29, Mining industry of Japan; 30, warden of mines, Johore; 31, consular report, Mar. 10, 1923; 32, Ann. Rept. Union minière du Haut Katanga; 33, consular report, Sept. 30, 1921; 34, Rept. Secretary for Mines; 35, Direction générale des travaux publics, Service des mines; 36, Ann. Rept. Dept. Mines and Industries; 37, Ann. Repts. Dept. Mines; 38, Ann. Repts. Under Secretary for Mines; 39, Review of mining operations, Dept. Mines; 40, Mineral resources of the Philippine Islands.

[b] Shipments. [c] No figures available. [d] From Tofo mine.

[e] Fiscal year Apr. 1 to Mar. 31. [f] Includes iron oxide used for paint and ironstone.

## BENEFICIATED IRON ORE.

The processes reported as employed in 1922 to improve the quality of the ore at mines were crushing and screening, drying by direct heat and by steam, hand picking on tables and on belts, washing by means of hydraulic jets and logs, jigging, electromagnetic separation, sintering, calcining, nodulizing, and desulphurization by sintering. Some of the operations combined two or more of these processes. Iron ores were reported as beneficiated at 83 mines in 12 States in 1922 and at 59 mines in 12 States in 1921. Some iron ore is also recovered in the form of dust from blast furnaces, but no statistics have been gathered on this subject. Ore so recovered has been originally accounted for in the statistics of shipments from the mines.

The most significant step in the field of beneficiating iron ore was the establishment on a shipping basis of the plant of the Mesabi Iron Co. at Babbitt, Minn. Here a metamorphosed rock containing 20 to 30 per cent of magnetite is crushed and ground very fine, and the magnetite is separated from the siliceous material by dry and wet magnetic separation, after which the concentrates are sintered to facilitate shipment. Prior to the starting of this plant in the fall of 1922 the Minnesota School of Mines experiment station and the Mesabi Iron Co. had been studying the problem of concentrating the magnetite in the rock of the eastern portion of the Mesabi range and had demonstrated that a very superior grade of ore could be produced in an experimental mill. It is probable that eventually the capacity of the plant at Babbitt will be increased so that large quantities of ore can be produced, for economical operation is believed to depend upon a large production.

The next logical step in the problem of beneficiation of iron ores, not only in the Lake Superior district but wherever there are lean hematites and limonites in large quantities convenient to transportation and markets, should be to develop a commercially successful process for reducing the hematite or limonite to a magnetic condition and then separating the magnetic ore from the nonmetallic impurities by electromagnetic action, as is now being done at Mineville, N. Y., and Mesabi, Minn. Such a process was employed for a time by the Mississippi Valley Iron Co. at its brown iron ore mine near Waukon, Iowa, but this plant has been inactive since 1918. Outlines of this process have been published by the Geological Survey.[10] As in the initial stages of development of the wet magnetic concentration process, the way to magnetic roasting (or reduction) is also being blazed by the Minnesota School of Mines Experiment Station.[11]

The total beneficiated ore reported as shipped from mines in the United States in 1922 increased 78 per cent in quantity and 66 per cent in value, as compared with 1921. From such figures as are available, showing the relation between crude ore treated and beneficiated ore recovered, it is apparent that in washing brown ore the ratios, by weight, of crude ore washed to resultant concentrates range from 6:1 to 1.25:1; in concentrating hematite from 1.841:1 to 1.051:1; in magnetite from 5.118:1 to 1.059:1; and in carbonate 1.333:1.

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[10] Burchard, E. F., Iron ore in Cass, Marion, Morris, and Cherokee counties, Tex.: U. S. Geol. Survey Bull. 620, pp. 103-104, 1915; see also Mineral Resources, 1916, pt. 1, p. 534, 1918.

[11] Davis, E. W., Magnetic concentration of iron ore: Minnesota School of Mines Exper. Sta. Bull. 9, 138 pp., December, 1921; Magnetic roasting of iron ores: Iron Trade Rev., Apr. 6, 1922, pp. 968-972.

*Beneficiated iron ore shipped from mines in the United States, 1920–1922.*

| State. | Variety. | 1921 | | 1922 | |
|---|---|---|---|---|---|
| | | Gross tons. | Value. | Gross tons. | Value. |
| Alabama | Hematite, brown ore | 327,792 | $834,431 | 803,369 | $2,133,695 |
| Georgia | Brown ore | (a) | (a) | 21,558 | 53,933 |
| Minnesota | Hematite, magnetite | 2,936,085 | 9,968,425 | 4,621,202 | 14,792,449 |
| New Jersey | Magnetite, brown ore | 115,132 | 551,688 | 90,374 | 400,356 |
| New York | Magnetite | 159,088 | 856,390 | 175,317 | 996,137 |
| North Carolina | Brown ore | (a) | (a) | 14,958 | 33,914 |
| Pennsylvania | Magnetite, brown ore | 101,129 | 493,482 | 559,109 | 2,107,480 |
| Tennessee | Hematite, brown ore | 21,001 | 59,236 | 133,026 | 343,470 |
| Virginia | do | 45,206 | 156,501 | 12,278 | 57,017 |
| Other States b | Hematite, brown ore, magnetite | 22,188 | 88,237 | 191,953 | 688,792 |
| | | 3,727,621 | 13,008,390 | 6,623,144 | 21,607,243 |

a Included under "Other States."
b 1921: Georgia, Maryland, Massachusetts, Missouri, New Mexico, and North Carolina; 1922: Massachusetts, Michigan, Missouri, and Wisconsin.

## IRON AND STEEL.

The records of the production and sales of iron and steel shown in the following pages are derived in part from producers who report directly to the United States Geological Survey and in part from several other authoritative sources, such as the American Iron and Steel Institute, Metal Statistics, the Iron Age, the Iron Trade Review, and the Bureau of Foreign and Domestic Commerce of the Department of Commerce.

### PIG IRON.

#### SHIPMENTS, VALUE, AND PRODUCTION, BY STATES.

The shipments of pig iron, exclusive of ferroalloys, reported to the United States Geological Survey by the manufacturers, represented an increase of 73 per cent in quantity and 56 per cent in gross value as compared with 1921. The values stated represent the approximate amounts received for the iron f. o. b. furnaces and do not include freight costs, selling commissions, and other items which are figured in some of the market prices of pig iron as published in the trade journals.

The pig iron shipped includes the metal produced from foreign as well as from domestic ore. The pig iron derived from ore imported from Africa, Brazil, Canada, Chile, China, Cuba, Spain, and Sweden, although it constitutes a very small percentage of the total production, amounted in 1922 to 649,111 gross tons, valued at $13,640,340, as compared with 165,620 tons, valued at $4,166,656, in 1921. In the manufacture in 1922 of 563,957 gross tons of pig iron, 929,523 gross tons of foreign iron ore, including 19,318 tons of cinder derived from foreign pyrite, was reported to have been used, thus indicating an average pig-iron yield of 61.21 per cent from imported ore. Domestic ore, including 4,265,869 gross tons of cinder, scale, and scrap and amounting to 50,751,559 gross tons, was reported as used in the manufacture of 26,257,253 tons of pig iron, thus indicating a yield of 51.74 per cent in pig iron from domestic materials. The total production of pig iron, exclusive of ferroalloys, reported to the Geological Survey was 26,826,210 gross tons, compared with 16,403,627 tons in 1921, an increase of about 64 per cent.

*Pig iron shipped from blast furnaces in the United States, 1921 and 1922, by States.*

| State. | 1921 | | 1922 | | | | | |
|---|---|---|---|---|---|---|---|---|
| | Gross tons. | Value. | Gross tons. | Value. | Increase or decrease. | | Percentage of increase or decrease. | |
| | | | | | Gross tons. | Value. | Quantity. | Value. |
| Alabama | 1,241,227 | $30,195,978 | 2,223,159 | $42,883,424 | +981,932 | +$12,687,446 | +79 | +42 |
| Illinois | 1,490,638 | 36,513,263 | 2,729,172 | 58,954,675 | +1,238,534 | +22,441,412 | +83 | +61 |
| Indiana | 1,655,275 | 36,945,411 | 2,191,356 | 43,064,817 | +536,081 | +6,119,406 | +32 | +17 |
| Kentucky | 28,375 | 816,372 | 140,217 | 2,951,627 | +111,842 | +2,135,255 | +394 | +262 |
| Michigan | 200,944 | 5,955,205 | 595,647 | 14,791,041 | +394,703 | +8,835,836 | +196 | +148 |
| Missouri | 17,028 | 479,957 | (a) | (a) | (b) | (b) | (b) | (b) |
| New York | 786,713 | 18,212,810 | 1,708,605 | 37,783,073 | +921,892 | +19,570,263 | +117 | +107 |
| Ohio | 3,649,835 | 88,473,082 | 6,756,648 | 149,805,909 | +3,106,813 | +61,332,827 | +85 | +69 |
| Pennsylvania | 6,072,196 | 148,350,285 | 9,732,024 | 221,581,288 | +3,659,828 | +73,231,003 | +60 | +49 |
| Tennessee | 21,972 | 595,850 | 95,326 | 2,063,376 | +73,354 | +1,467,526 | +334 | +246 |
| Virginia | 66,916 | 2,023,268 | 31,022 | 793,903 | −35,894 | −1,229,365 | −54 | −61 |
| West Virginia | 259,312 | 6,557,498 | 309,944 | 7,537,184 | +50,632 | +979,686 | +20 | +15 |
| Wisconsin | 93,666 | 2,730,155 | 209,289 | 4,970,227 | +115,623 | +2,240,072 | +123 | +82 |
| Other States c | 454,522 | 11,588,658 | 948,329 | 20,964,314 | +b 476,779 | +b 8,895,699 | +b 101 | +b 74 |
| | 16,038,619 | 389,437,792 | 27,670,738 | 608,144,858 | +11,632,119 | +218,707,066 | +73 | +56 |

a Included under "Other States."
b Decrease for Missouri included under "Other States."
c 1921: Colorado, Connecticut, Maryland, Massachusetts, Minnesota, and New Jersey; 1922: Colorado, Connecticut, Maryland, Massachusetts, Minnesota, Missouri, and New Jersey.

*Pig iron shipped from blast furnaces in the United States in 1921 and 1922, by grades.*

| Grade. | 1921 | | | 1922 | | |
|---|---|---|---|---|---|---|
| | Gross tons. | Value. | Average price. | Gross tons. | Value. | Average price. |
| Charcoal | 79,727 | $2,964,106 | $37.18 | 232,244 | $6,447,924 | $27.76 |
| Foundry | 2,285,554 | 58,711,067 | 25.69 | 3,877,201 | 85,587,682 | 22.07 |
| Basic | 7,755,612 | 179,355,963 | 23.13 | 14,359,461 | 306,257,984 | 21.33 |
| Bessemer | 5,345,646 | 133,181,663 | 24.91 | 7,723,335 | 175,082,881 | 22.67 |
| Low phosphorus | 74,517 | 2,759,054 | 37.03 | 152,023 | 4,359,606 | 28.68 |
| Malleable | 325,901 | 8,179,596 | 25.10 | 1,036,786 | 23,521,993 | 22.69 |
| Forge | 128,062 | 3,182,081 | 24.85 | 211,601 | 5,063,516 | 23.93 |
| All other (not ferroalloys) | 43,600 | 1,104,262 | 25.33 | 78,087 | 1,823,272 | 23.35 |
| | 16,038,619 | 389,437,792 | 24.28 | 27,670,738 | 608,144,858 | 21.98 |

The American Iron and Steel Institute reports that the output in 1922 of all kinds of pig iron, including ferroalloys, produced in blast furnaces, as well as some that was electrically produced, increased 10,531,778 tons, or 63 per cent, as compared with 1921.

*Pig iron, including ferroalloys, manufactured in the United States in 1921 and 1922, in gross tons.*[a]

| State. | 1921 | 1922 | State. | 1921 | 1922 |
|---|---|---|---|---|---|
| Pennsylvania | 6,252,766 | 9,731,788 | Missouri, Iowa, Colorado, Montana, Washington | 226,364 | 266,716 |
| Ohio | 3,799,613 | 6,484,162 | | | |
| Illinois | 1,612,033 | 2,625,244 | | | |
| Alabama | 1,207,408 | 2,230,619 | | | |
| Indiana, Michigan | 1,893,611 | 2,726,727 | | | |
| New York, New Jersey | 968,660 | 1,772,325 | Maryland | 147,189 | 366,967 |
| | | | Tennessee | 19,479 | 123,907 |
| Wisconsin, Minnesota | 226,863 | 381,030 | Connecticut, Massachusetts, Maine | 2,142 | 1,084 |
| West Virginia, Kentucky | 264,759 | 460,311 | | | |
| Virginia | 67,239 | 49,024 | | 16,688,126 | 27,219,904 |

a American Iron and Steel Institute.

## AVERAGE PRICES.

### PRICES AT BLAST FURNACES.

The average prices of all kinds of pig iron given in the following table are based on reports of the manufacturers to the Geological Survey. The figures represent the approximate prices f. o. b. at the blast furnaces and do not include the prices of ferroalloys. The general average price for all grades of pig iron at the furnaces, exclusive of ferroalloys, showed a decrease of 9 per cent for 1922.

*Average price per gross ton of pig iron at blast furnaces in the United States, 1917–1922.*

| State. | 1917 | 1918 | 1919 | 1920 | 1921 | 1922 |
|---|---|---|---|---|---|---|
| Alabama | $21.64 | $30.58 | $25.96 | $32.70 | $24.33 | $19.29 |
| Illinois | 26.34 | 30.91 | 24.42 | 28.02 | 24.50 | 21.60 |
| Indiana | (a) | 29.09 | 22.51 | 25.58 | 22.32 | 19.65 |
| Kentucky | 28.78 | 34.19 | 30.06 | 31.72 | 28.77 | 21.05 |
| Michigan | 29.93 | 35.44 | 32.23 | 36.22 | 29.64 | 24.83 |
| Missouri | (a) | 36.97 | 33.40 | 45.04 | 28.19 | (a) |
| New Jersey | 35.25 | 34.22 | 31.48 | 38.23 | (a) | (a) |
| New York | 22.98 | 28.27 | 26.84 | 37.02 | 23.15 | 22.11 |
| Ohio | 27.30 | 30.31 | 25.59 | 29.93 | 24.24 | 22.17 |
| Pennsylvania | 29.87 | 31.69 | 25.86 | 33.27 | 24.43 | 22.77 |
| Tennessee | 26.26 | 34.08 | 33.10 | 42.55 | 27.12 | 21.65 |
| Virginia | 27.93 | 34.00 | 31.53 | 41.21 | 30.24 | 25.59 |
| West Virginia | (a) | (a) | 25.04 | 32.53 | 25.29 | 24.32 |
| Wisconsin | 27.39 | 38.08 | 29.42 | 33.98 | 29.15 | 23.75 |
| Other States [b] | 24.25 | 28.52 | 25.92 | 33.87 | 25.50 | 22.11 |
| Average for United States | 27.29 | 30.89 | 25.75 | 31.95 | 24.28 | 21.98 |

[a] Included under "Other States."

[b] 1917: Colorado, Connecticut, Georgia, Indiana, Maryland, Massachusetts, Minnesota, Missouri, Washington, and West Virginia; 1918: Colorado, Connecticut, Georgia, Maryland, Massachusetts, Minnesota, Washington, and West Virginia; 1919: Colorado, Connecticut, Maryland, Massachusetts, Minnesota, Texas, and Washington; 1920: Colorado, Connecticut, Maryland, Massachusetts, and Minnesota; 1921: Colorado, Connecticut, Maryland, Massachusetts, Minnesota, and New Jersey; 1922: Colorado, Connecticut, Maryland, Massachusetts, Minnesota, Missouri, and New Jersey.

*Average price per gross ton of pig iron at blast furnaces in the United States, 1889–1922.*

| | | | | | | | | |
|---|---|---|---|---|---|---|---|---|
| 1889 | $15.78 | 1898 | $9.90 | 1907 | $20.56 | 1915 | $13.21 |
| 1890 | 16.43 | 1899 | 18.00 | 1908 | 15.96 | 1916 | 16.96 |
| 1891 | 15.50 | 1900 | 18.85 | 1909 | 16.25 | 1917 | 27.29 |
| 1892 | 14.32 | 1901 | 15.25 | 1910 | 15.45 | 1918 | 30.89 |
| 1893 | 11.90 | 1902 | 20.92 | 1911 | 14.07 | 1919 | 25.75 |
| 1894 | 9.76 | 1903 | 19.12 | 1912 | 13.93 | 1920 | 31.95 |
| 1895 | 11.14 | 1904 | 14.13 | 1913 | 15.08 | 1921 | 24.28 |
| 1896 | 10.47 | 1905 | 16.63 | 1914 | 13.42 | 1922 | 21.98 |
| 1897 | 9.85 | 1906 | 19.98 | | | | |

### COMMERCIAL QUOTATIONS.

The average monthly prices of the principal grades of pig iron, either at the blast furnaces or at the nearest market in 1921 and 1922, according to published market quotations, are summarized in the following table for comparison with figures reported by blast-furnace operators as shown in preceding tables. The average commercial quotations for three of the four grades of iron show an increase and are apparently higher than the average prices reported by the manufacturers, and so in comparing these prices it should be borne in mind that the manufacturers' prices represent weighted averages of what was actually received by them for the metal and that a discrepancy is to be expected between the two sets of prices. Commercial quotations of prices of basic pig iron for the last seven years are shown graphically in Figure 13. These years include the period during which the United States was involved in the World War, and the contrast between the high and low prices is shown more markedly

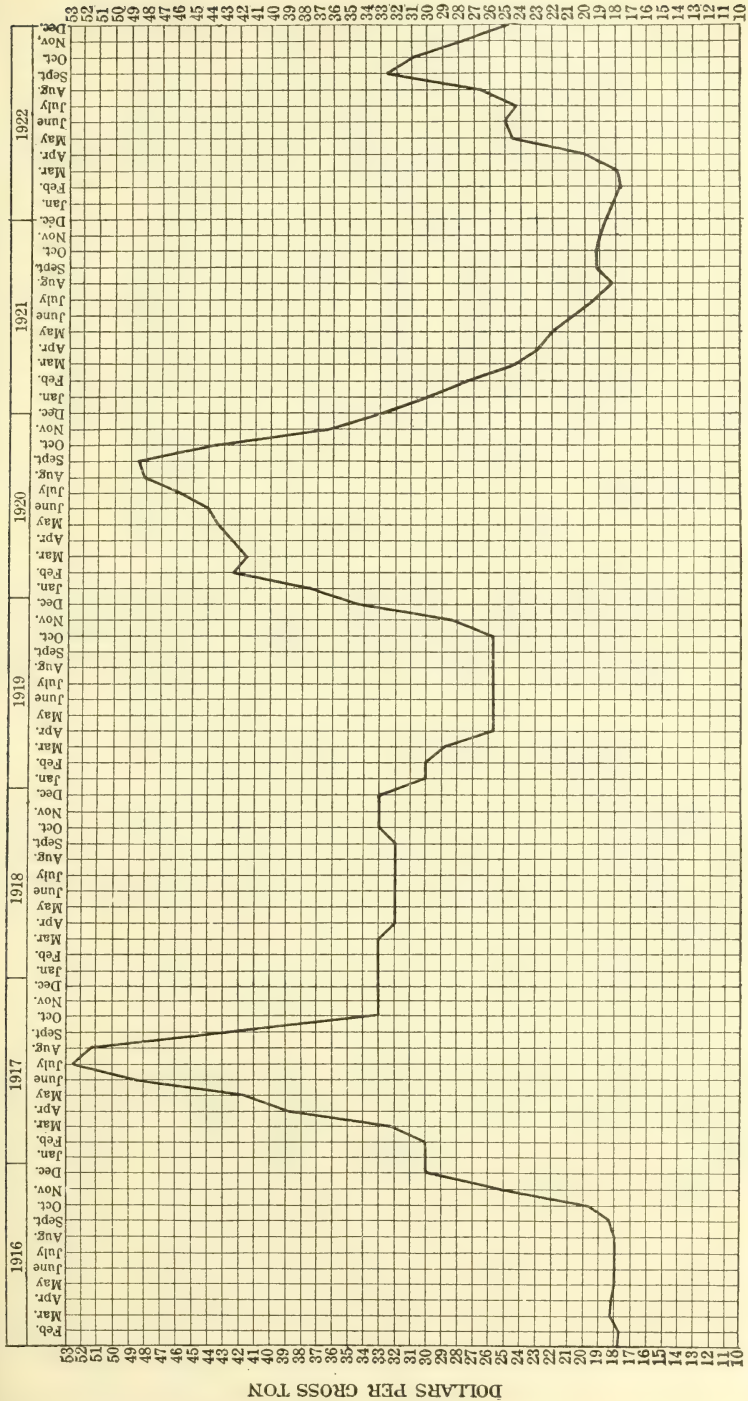


FIGURE 13.—Curve showing commercial quotations of basic pig iron at blast furnaces in Mahoning and Shenango valleys, Ohio and western Pennsylvania, 1916–1922, by months. Statistics from the Iron Age, Jan. 4, 1923, p. 60.

than it would be in tabular form. The steady decline and generally low price in 1921 and the feeble rise in 1922 are of interest in comparison with the soaring prices of 1917 and 1920.

*Average monthly prices per ton of principal grades of pig iron, 1921 and 1922.*[a]

| Month. | Foundry pig iron at Valley furnaces. | | Foundry pig iron at Birmingham furnaces. | | Bessemer pig iron at Valley furnaces. | | Basic pig iron at Valley furnaces. | |
|---|---|---|---|---|---|---|---|---|
| | 1921 | 1922 | 1921 | 1922 | 1921 | 1922 | 1921 | 1922 |
| January | $31.92 | $19.38 | $31.14 | $15.96 | $32.00 | $19.62 | $30.00 | $18.19 |
| February | 28.29 | 18.92 | 27.50 | 15.33 | 29.63 | 19.40 | 27.71 | 18.00 |
| March | 25.89 | 18.87 | 25.52 | 15.31 | 26.70 | 19.02 | 24.41 | 17.89 |
| April | 24.81 | 20.74 | 23.77 | 15.74 | 25.00 | 20.88 | 23.00 | 19.98 |
| May | 23.60 | 24.00 | 21.80 | 17.63 | 24.32 | 25.08 | 22.15 | 24.62 |
| June | 22.42 | 24.00 | 20.48 | 18.44 | 22.88 | 25.00 | 21.20 | 25.00 |
| July | 20.40 | 24.20 | 20.18 | 18.56 | 21.34 | 25.00 | 19.52 | 24.32 |
| August | 19.59 | 29.04 | 18.70 | 20.37 | 20.00 | 27.74 | 18.22 | 26.17 |
| September | 20.86 | 35.02 | 19.06 | 25.40 | 20.00 | 33.76 | 19.00 | 30.08 |
| October | 21.00 | 31.63 | 19.00 | 27.04 | 20.00 | 33.23 | 19.24 | 30.23 |
| November | 20.78 | 28.78 | 18.56 | 24.12 | 20.00 | 31.70 | 19.00 | 28.28 |
| December | 20.00 | 25.92 | 17.31 | 22.70 | 20.00 | 27.78 | 19.00 | 24.96 |
| Average | 23.30 | 25.04 | 21.92 | 19.72 | 23.49 | 25.68 | 21.87 | 23.98 |

[a] Metal Statistics, 1923.

## DAILY AVERAGE PRODUCTION.

The daily average production of coke and anthracite pig iron, by months, during the last seven years is graphically illustrated in Figure 14. The curves of prices and production show little similarity until the later part of 1920, when the laws of demand and supply began to operate more normally than in the preceding four or five years.

## PRODUCTION BY GRADES AND BY FUEL USED.

The statistics of production of pig iron by grades and by fuel used for 1918–1922, the total production of pig iron, and the number of furnaces in blast in 1921–1922 have been published by the American Iron and Steel Institute as given below. These figures include ferroalloys. Metals made with electricity and with coke and electricity are included in coke pig iron.

*Pig iron manufactured in the United States, 1918–1922, by grades, in gross tons.*

| Grade. | 1918 | 1919 | 1920 | 1921 | 1922 |
|---|---|---|---|---|---|
| Bessemer and low phosphorus | 13,024,966 | 9,975,934 | 12,062,084 | 5,595,215 | 7,813,203 |
| Basic | 18,646,174 | 14,494,131 | 16,737,722 | 7,753,071 | 13,841,367 |
| Forge | 393,932 | 271,286 | 318,048 | 112,748 | 214,210 |
| Foundry and ferrosilicon | 5,145,260 | 4,916,758 | 5,957,782 | 2,568,136 | 3,976,431 |
| Malleable | 1,117,914 | 1,009,049 | 1,310,951 | 457,340 | 1,051,495 |
| Spiegeleisen | 283,853 | 84,246 | 111,449 | 56,423 | 73,443 |
| Ferromanganese | 333,027 | 185,357 | 295,447 | 103,755 | 150,115 |
| White, mottled, direct castings, etc | 109,518 | 78,603 | 132,504 | 41,438 | 99,640 |
| | 39,054,644 | 31,015,364 | 36,925,987 | 16,688,126 | 27,219,904 |

*Pig iron manufactured in the United States, 1918–1922, by fuel used, in gross tons.*

| Fuel used. | 1918 | 1919 | 1920 | 1921 | 1922 |
|---|---|---|---|---|---|
| Bituminous, chiefly coke | 38,422,175 | 30,549,930 | 36,300,024 | 16,579,653 | 26,995,173 |
| Anthracite and coke | 283,592 | 138,337 | 302,567 | 13,743 | ..... |
| Charcoal | 348,877 | 327,097 | 323,396 | 94,730 | 224,731 |
| | 39,054,644 | 31,015,364 | 36,925,987 | 16,688,126 | 27,219,904 |

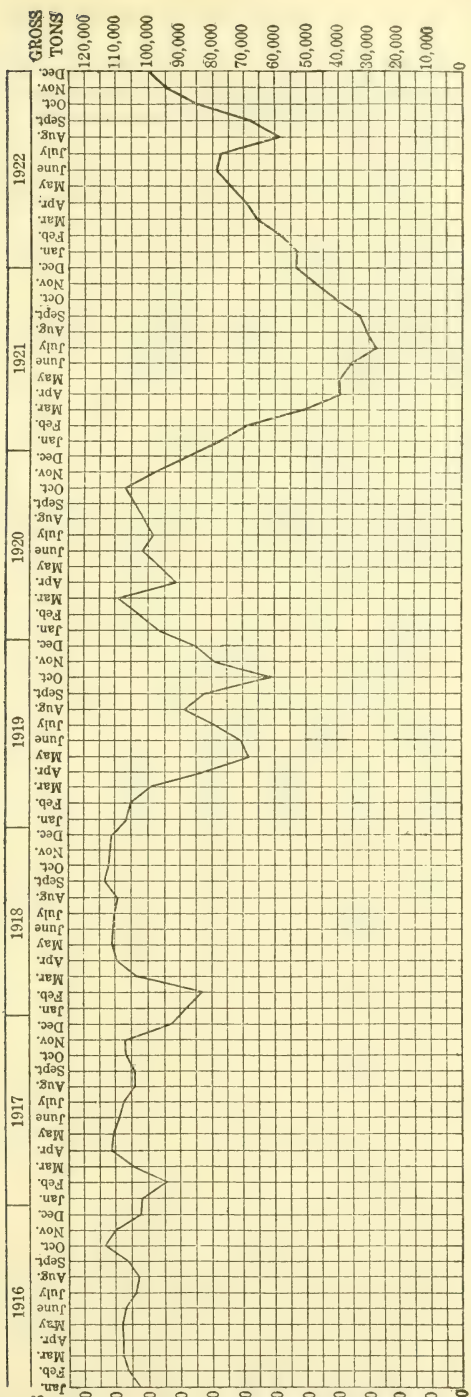


FIGURE 14.—Curve showing daily average production of coke and anthracite pig iron in the United States, by months, 1916–1922.
Statistics from the Iron Age, Jan. 4, 1923, p. 112.

## TOTAL DOMESTIC PRODUCTION OF PIG IRON.

The next table shows the production in the United States of pig iron, including the commoner ferroalloys, as far as has been recorded. Statistics by years prior to 1916 will be found in Mineral Resources for 1918 and earlier years.

*Pig iron manufactured in the United States, 1810–1922.*

| Year. | Gross tons. | Year. | Gross tons. | Year. | Gross tons. |
|---|---|---|---|---|---|
| 1810–1860 | 10,542,548 | 1911–1915 | 137,591,093 | 1921 | 16,688,126 |
| 1861–1870 | 11,366,963 | 1916 | 39,434,797 | 1922 | 27,219,904 |
| 1871–1880 | 24,055,278 | 1917 | 38,621,216 | | |
| 1881–1890 | 56,902,041 | 1918 | 39,054,644 | | 778,864,649 |
| 1891–1900 | 98,124,754 | 1919 | 31,015,364 | | |
| 1901–1910 | 211,321,934 | 1920 | 36,925,987 | | |

## BLAST FURNACES.

The number of furnaces in blast on June 30 and December 31 and the total number of stacks recorded for 1921 and 1922, not including any electric reduction furnaces, are as follows:

*Blast furnaces in the United States, 1921 and 1922.*

| State. | In blast June 30, 1921. | Dec. 31, 1921. | | | In blast June 30, 1922. | Dec. 31, 1922. | | |
|---|---|---|---|---|---|---|---|---|
| | | In. | Out. | Total. | | In. | Out. | Total. |
| Pennsylvania | 27 | 46 | 115 | 161 | 69 | 90 | 70 | 160 |
| Ohio | 14 | 26 | 54 | 80 | 41 | 58 | 22 | 80 |
| Illinois | 6 | 9 | 17 | 26 | 16 | 18 | 8 | 26 |
| Alabama | 8 | 13 | 30 | 43 | 22 | 25 | 18 | 43 |
| New York | 3 | 10 | 17 | 27 | 13 | 15 | 12 | 27 |
| Virginia | 2 | | 17 | 17 | | 4 | 13 | 17 |
| Tennessee | | 1 | 16 | 17 | 2 | 6 | 11 | 17 |
| Colorado | 2 | 1 | 4 | 5 | 3 | 3 | 2 | 5 |
| Missouri | 1 | | 3 | 3 | | | 3 | 3 |
| Oregon | | | 1 | 1 | | | 1 | 1 |
| Maryland | 1 | 1 | 6 | 7 | 4 | 4 | 3 | 7 |
| New Jersey | 1 | 1 | 3 | 4 | 1 | 1 | 3 | 4 |
| Wisconsin | 1 | 1 | 6 | 7 | 3 | 4 | 3 | 7 |
| Minnesota | | | 3 | 3 | 2 | 3 | | 3 |
| Indiana | 7 | 9 | 7 | 16 | 12 | 14 | 2 | 16 |
| Michigan | 2 | 4 | 9 | 13 | 9 | 13 | | 13 |
| West Virginia | 1 | 2 | 3 | 5 | 2 | 3 | 2 | 5 |
| Kentucky | | 1 | 6 | 7 | 2 | 1 | 6 | 7 |
| Georgia | | | 3 | 3 | | | 3 | 3 |
| Texas | | | 1 | 1 | | | 1 | 1 |
| Mississippi | | | 1 | 1 | | | 1 | 1 |
| Connecticut | | | 2 | 2 | | | 2 | 2 |
| Massachusetts | | | 1 | 1 | | 1 | | 1 |
| | 76 | 125 | 325 | 450 | 201 | 263 | 186 | 449 |

## FOREIGN TRADE IN PIG IRON.

The quantity of pig iron and ferroalloys, principally ferromanganese and ferrosilicon, imported into the United States in 1922 increased 1,019 per cent, compared with 1921. Separate statistics of imports of ferroalloys, given on page 372, indicate that the imports of pig iron alone (by difference) were 374,666 gross tons in 1922, compared with 26,794 tons in 1921. England, Scotland, and Belgium furnished the largest quantity of these products in 1922.

*Pig iron, including kentledge, ferromanganese, ferrosilicon, and spiegeleisen, imported into the United States, 1918–1922, in gross tons.*

| Country. | 1918 | 1919 | 1920 | 1921 | 1922 |
|---|---|---|---|---|---|
| North America: | | | | | |
| Canada | 5,692 | 63,091 | 101,071 | 9,651 | 30,889 |
| Cuba | | 30 | | | |
| Mexico | 120 | 5,994 | | | |
| Newfoundland and Labrador | | | | 13 | |
| Panama | | | | | 141 |
| South America: Brazil | | | 466 | | |
| Europe: | | | | | |
| Belgium | | | | 12,004 | 64,480 |
| France | | | 5 | 127 | 41,744 |
| Germany | | | | 3,508 | 5,040 |
| Netherlands | | | | | 3,037 |
| Norway | | | | | 674 |
| Sweden | | 51 | 105 | 1,088 | 413 |
| Switzerland | | | | 10 | 5 |
| United Kingdom—England | 28,392 | 32,452 | 64,008 | 9,302 | 246,721 |
| United Kingdom—Scotland | | 39 | 10,208 | | 98,950 |
| Asia: | | | | | |
| British India | 501 | | 1,977 | | |
| China | | 8 | 3,555 | 4,610 | 502 |
| Hongkong | | | | 250 | |
| Japan | 6 | | 3,851 | 2,002 | |
| Kwangtung | | | 200 | 1,213 | |
| Oceania: Australia | | | 498 | 258 | |
| | 34,711 | 101,665 | 185,944 | 44,036 | 492,596 |

The pig iron exported from the United States in 1922 increased 17 per cent in quantity but decreased 7 per cent in value, as compared with 1921. Canada was the best customer in 1922, having taken 74 per cent of the total pig iron exported. The average price reported as received per ton was $26.43 in 1922, compared with $32.96 in 1921.

*Pig iron (including ferroalloys) exported from the United States, 1918–1922, in gross tons.*

| Country. | 1918 | 1919 | 1920 | 1921 | 1922 |
|---|---|---|---|---|---|
| North America: | | | | | |
| Canada | 122,325 | 33,751 | 56,100 | 16,271 | 24,539 |
| Cuba | 892 | 1,331 | 1,268 | 301 | 216 |
| Mexico | 297 | 1,103 | 2,348 | 1,534 | 1,297 |
| Panama | 881 | 483 | 624 | 662 | 1 |
| Other countries | 385 | 787 | 165 | 106 | 82 |
| South America: | | | | | |
| Argentina | 129 | 4,137 | 2,121 | 23 | 53 |
| Brazil | 72 | 979 | 951 | 84 | 190 |
| Chile | 4,345 | 6,611 | 2,545 | 471 | 313 |
| Peru | 694 | 1,253 | 280 | 729 | 499 |
| Other countries | 74 | 365 | 666 | 85 | 256 |
| Europe: | | | | | |
| Austria-Hungary | | 417 | | | |
| Belgium | | 8,625 | 28,680 | 1,359 | 572 |
| Denmark | | 5,776 | 2,238 | | 25 |
| France | 8,181 | 683 | 451 | 77 | 170 |
| Germany | | | 14,074 | 904 | 536 |
| Italy | 41,641 | 136,997 | 36,128 | 300 | |
| Netherlands | | 5,220 | 20,384 | | |
| Norway | 1,000 | 2,995 | 1,510 | | |
| Sweden | | 2,844 | 8,207 | 300 | |
| Switzerland | | | 2,649 | | |
| United Kingdom— | | | | | |
| England | 66,197 | 34,741 | 11,127 | 4,194 | 2,316 |
| Scotland | 7,591 | 11,268 | 5,868 | | 5 |
| Ireland | 313 | | | | |
| Other countries | | 1,618 | 681 | 50 | |
| Asia: | | | | | |
| China | 361 | 4,818 | 707 | | 996 |
| Dutch East Indies | | 1,620 | 1,651 | 50 | |
| Hongkong | 1,164 | 1,081 | 151 | | 10 |
| Japan | 11,986 | 49,734 | 13,448 | 320 | 135 |
| Other countries | | 174 | 239 | 271 | 200 |
| Africa | 16 | 22 | | | |
| Oceania: | | | | | |
| Australia | 30 | 259 | 485 | | 42 |
| New Zealand | | 716 | 270 | | |
| Philippine Islands | 995 | 853 | 787 | 216 | 552 |
| Other countries | 6 | | 25 | | |
| | 269,575 | 321,261 | 216,828 | 28,307 | 33,005 |
| Value | $11,576,721 | $12,313,183 | $10,074,377 | $933,093 | $872,343 |

## PRODUCTION BY COUNTRIES.

In compiling the table of production of pig iron by countries since the war it has been necessary to use such statistics as are available and to revise figures from year to year as more complete and reliable data are obtained. For a time figures for the normal year 1913 were given for comparison, but changes in boundaries of countries in Europe have rendered comparisons with pre-war figures confusing. Of the countries producing more than 1,000,000 tons each in 1922 all showed large increases except Germany. The predominant position of the United States in pig-iron production is well shown, and the table in connection with that of exports from the United States indicates that the consumption in the principal European countries is still very moderate.

*Pig iron (including ferroalloys) produced, 1919–1922, by countries, in metric tons.*

| Country. | 1919 | 1920 | 1921 | 1922 | Source of data.[a] |
|---|---|---|---|---|---|
| Australia | 257,828 | 349,521 | 358,020 | 84,874 | 1919–1922, 1. |
| Austria | 61,880 | 99,766 | 224,031 | 322,822 | 1919–1921, 2; 1922, 3. |
| Belgium | 250,570 | 1,116,400 | 872,010 | 1,497,610 | 1919–1922, 4. |
| Canada | 876,682 | 1,014,743 | 559,591 | 366,325 | 1919–1920, 5; 1921–1922, 5a. |
| China | [b] 163,911 | [b] 185,389 | 150,000 | (c) | 1919–1921, 6. |
| Chosen | 79,995 | 38,555 | 83,273 | 83,221 | 1919–1920, 7; 1921–1922, 8. |
| Czechoslovakia | (c) | 701,137 | 917,662 | (c) | 1920, 9; 1921, 10. |
| Finland | 7,186 | 12,961 | 7,080 | (c) | 1919–1921, 10a. |
| France | 2,447,295 | 3,433,791 | 3,400,000 | 5,128,608 | 1919, 11; 1920, 12; 1921–1922, 3. |
| Germany | 5,604,408 | 5,657,000 | 6,194,000 | 6,604,000 | 1919, 13; 1920–1922, 14. |
| Hungary | (c) | 30,000 | 51,000 | 117,000 | 1920–1922, 14. |
| India | 360,037 | 348,537 | 401,548 | (c) | 1919–1921, 15. |
| Italy | 256,227 | 108,953 | 76,974 | 113,400 | 1919–1922, 16. |
| Japan | 209,357 | 168,870 | 96,648 | (c) | 1919–1921, 17. |
| Luxemburg | 617,422 | 692,935 | 970,336 | 1,679,328 | 1919–1921, 18; 1922, 31. |
| Norway | 3,555 | 5,771 | 2,509 | 3,759 | 1919–1922, 19. |
| Philippine Islands | 67 | 87 | (c) | (c) | 1919–1920, 20. |
| Poland | 15,214 | 42,221 | 60,000 | 480,554 | 1919–1922, 21. |
| Russia [d] | 113,025 | 103,688 | 122,853 | 166,828 | 1919–1922, 22. |
| Rumania [e] | 11,838 | 19,007 | 33,362 | 31,419 | 1919–1922, 23. |
| Spain | 294,167 | 251,412 | 347,497 | 209,792 | 1919–1921, 24; 1922, 24a. |
| Sweden | [f] 509,885 | [f] 488,437 | 320,037 | 264,259 | 1919–1921, 25; 1922, 25a. |
| Union of South Africa | 1,780 | 1,368 | 1,041 | ..... | 1919–1922, 26. |
| United Kingdom | 7,536,450 | 8,163,674 | 2,653,313 | 4,978,137 | 1919–1920, 27; 1921–1922, 28. |
| United States | 31,513,161 | 37,518,649 | 16,955,970 | 27,656,783 | 1919–1922, 29. |
| Yugoslavia | (c) | 15,173 | 13,061 | 18,800 | 1920–1922, 30. |

[a] 1, Australian Metal Exchange; 2, Staatsamte für Handel und Gewerbe-Industrie und Bauten; 3, Iron and Coal Trades Review; 4, Statistique des industries extractives et métallurgiques; 5, Canada Dept. Mines, Mines Branch; 5a, Dominion Bureau of Statistics; 6, Director of the Geological Survey of China, through the American consul general at Tientsin; 7, Mining Industry of Japan, Financial and Economic Annual of Japan (Tokyo), data furnished by the American embassy, Tokyo, the American consul general, Keijo (Seoul), and the American consul, Taihoku; 8, American consul, Seoul; 9, State Statistical Office; 10, Montanistiche Rundschau; 10a, Data from Industristyrelsen through American consul; 11, Statistique de l'industrie minérale; 12, consular report, May 12, 1921; 13, Statistisches Reichsamt; 14, Iron Trade Rev., Jan. 4, 1923, p. 27; 15, Records Geol. Survey India; 16, Rivista del servizio minerario; 17, Financial and Economic Annual; 18, American consul general, Rotterdam; 19. Bergverksdrift Offisielle Statistikk; 20, Mineral Resources of the Philippines; 21, Polish Government through the American legation, Warsaw; 22, Commerce Repts., Jan. 12, 1923; 23, Statistique minière de la Roumanie; 24, Estadística minera de España; 24a, Revista minera, metalúrgica y de ingeniería; 25, Sveriges officiella Statistik, Bergshantering; 25a, Commerce Repts., Aug. 20, 1923; 26, Annual Repts. Dept. of Mines and Industries; 27, Mines and Quarries (London); 28, Colliery Guardian; 29, American Iron and Steel Institute; 30, Ministry of Forests and Mines, through the American minister; 31, Min. Jour., London.

[b] Exports.

[c] No figures available.

[d] Year ending September 30.

[e] Year ending March 31.

[f] Includes sponge iron.

## FERROALLOYS.

### SHIPMENTS, VALUE, AND PRICE.

The statistics of output of ferroalloys in the United States were separated from those of pig iron in these reports in order to arrive at more nearly accurate values for these commodities. Although the quantity of ferroalloys is small compared with the total shipments of pig iron, the prices per ton are so much greater that they would unduly increase the apparent average price of the pig iron if included.

The shipments of ferroalloys of all classes in 1922, according to reports of all producers, increased 70 per cent in quantity and 30 per cent in value, as compared with 1921. The ferrovanadium, ferromolybdenum, ferromanganese, spiegeleisen, ferrotungsten, ferrochromium, and ferrotitanium were made in part or wholly from ore imported from Africa, Bolivia, Brazil, China, Cuba, India, Mexico, New Caledonia, Peru, Russia, and Turkey.

A review of the technical developments and market conditions of the ferroalloy industry, with comments on the effect of the new tariff duties, was published early in 1923,[12] but lack of space precludes any attempt to make an abstract of this excellent paper.

In 1922 ferromanganese was reported as made at 6 localities in the United States, spiegeleisen at 4, ferrosilicon at 11, ferrophosphorus at 2, ferrochromium at 6, ferromolybdenum at 2, ferrotitanium at 2, ferrotungsten at 6, ferrozirconium at 1, zirconium-ferrosilicon at 1, ferrocarbide at 1, ferrovanadium at 6, and silico-manganese at 1. In many localities, of course, several alloys were made at the same plant. There were 20 plants at which ferroalloys were made electrically or by a special process not involving a blast furnace.

The following records of average contract prices of ferromanganese and of spiegeleisen by months for the last four years show a wide range. The ferromanganese prices are quoted for material "delivered at Pittsburgh"; those of spiegeleisen are prices at producers' furnaces.

*Ferroalloys of domestic manufacture shipped from furnaces in the United States, 1921 and 1922.*

| Variety of alloy. | 1921 | | 1922 | |
|---|---|---|---|---|
| | Gross tons. | Value. | Gross tons. | Value. |
| Ferromanganese [a] | 111,374 | $13,654,800 | 161,612 | $10,673,638 |
| Spiegeleisen | [b] 69,230 | [b] 2,838,692 | 70,253 | 2,162,836 |
| Ferrosilicon (7 per cent or more silicon) | 55,099 | 2,548,827 | 154,866 | 7,109,928 |
| Ferromolybdenum | 19 | 43,866 | 108 | 267,168 |
| Ferrotungsten | 195 | 193,914 | 610 | 641,238 |
| Other varieties [c] | 12,710 | 2,417,686 | 35,831 | 7,404,196 |
| | 248,627 | 21,697,785 | 423,280 | 28,259,004 |

[a] Includes a small quantity of silico-manganese.
[b] Includes a small quantity of silico-spiegel.
[c] 1921: Ferrocarbide, ferrocerium, ferrochromium, ferrophosphorus, ferrotantalum-columbium, ferrotitanium, ferrovanadium, ferrozirconium, and zirconium-ferrosilicon; 1922: Ferrocarbide, ferrochromium, ferrophosphorus, ferrotitanium, ferrovanadium, ferrozirconium, and zirconium-ferrosilicon.

[12] Anderson, R. J., The ferroalloy industry in 1922: Iron Age, Jan. 4, 1923, pp. 58–61.

*Quoted prices per ton of ferromanganese and spiegeleisen, 1919–1922.*[a]

| Month. | Ferromanganese [Delivered at Pittsburgh.] | | | | Spiegeleisen [At producer's furnace.] | | | |
|---|---|---|---|---|---|---|---|---|
| | 1919 | 1920 | 1921 | 1922 | 1919 | 1920 | 1921 | 1922 |
| January | [b] $212.50 | $146.00 | $101.00 | $61.90 | [c] $67.50 | $46.60 | $46.25 | $25.50 |
| February | 165.00 | 160.00 | 96.85 | 65.32 | [c] 52.50 | 57.60 | 37.75 | 28.00 |
| March | 134.00 | 172.00 | 89.00 | 67.82 | [c] 42.50 | 60.40 | 34.20 | 28.00 |
| April | 113.75 | 200.00 | 87.50 | 69.07 | [c] 34.50 | 66.85 | 32.00 | 30.00 |
| May | 110.00 | 200.00 | 83.00 | 72.32 | [c] 31.35 | 75.00 | 31.75 | 35.00 |
| June | 111.75 | 198.00 | 76.50 | 72.82 | [c] 27.50 | 75.00 | 29.60 | 35.25 |
| July | 111.00 | 190.00 | 75.00 | 72.29 | 34.00 | 75.00 | 27.50 | 35.00 |
| August | 110.00 | 193.75 | 70.75 | 72.29 | 34.00 | 79.35 | 26.20 | 37.00 |
| September | 105.00 | 172.40 | 64.75 | 80.59 | 34.00 | 82.00 | 25.25 | 38.00 |
| October | 110.00 | 156.40 | 61.65 | 105.47 | 34.00 | 80.00 | 24.85 | 37.75 |
| November | 110.00 | 153.00 | 60.00 | 104.91 | 34.00 | 74.35 | 25.00 | 36.80 |
| December | 121.00 | 120.00 | 60.00 | 104.91 | 39.00 | 64.40 | 25.00 | 35.75 |

[a] Iron Trade Review.
[b] Price for January, 1919, based on 70 per cent ferromanganese; all other prices based on 80 per cent.
[c] Prices from January to June, 1919, inclusive, based on 16 per cent spiegeleisen; all other prices based on 20 per cent.

## IMPORTS AND EXPORTS.

The imports of the alloys of the rarer metals are not all reported separately. For instance, the imports of ferrochromium, ferromolybdenum, and ferrotungsten are included with those of their respective metals. The average values per ton of those imported ferroalloys that are shown individually were as follows: Ferrophosphorus, 1921, $26.40; ferrosilicon, 1922, $56.24, 1921, $49.43; ferromanganese, 1922, $64.47, 1921, $97.88; spiegeleisen, 1922, $32.90, 1921, $34.11. Ferromanganese constituted the bulk of the imports, and the imports of this alloy were equivalent to nearly 59 per cent of the domestic production. Most of these imports came from England.

The exports of ferroalloys are relatively unimportant, and although they increased about 84 per cent in quantity in 1922 the total value decreased nearly 58 per cent, according to available statistics. Ferromanganese constituted the greater part of the exports.

*Ferroalloys imported for consumption in the United States, 1920–1922.*

| Variety of alloy. | 1920 | | 1921 | | 1922 | |
|---|---|---|---|---|---|---|
| | Gross tons. | Value. | Gross tons. | Value. | Gross tons. | Value. |
| Chrome or chromium and ferrochromium | 1,751 | $428,619 | 452 | $106,669 | 397 | $118,870 |
| Ferrophosphorus | 6 | 780 | 5 | 132 | ..... | ..... |
| Ferrosilicon | 13,909 | 719,446 | 7,858 | 388,420 | 14,772 | 830,808 |
| Molybdenum and ferromolybdenum | ..... | ..... | (a) | 349 | 13 | 36,246 |
| Titanium and ferrotitanium | 1 | 713 | 2 | 1,299 | 24 | 11,607 |
| Tungsten and ferrotungsten | 892 | 1,180,829 | 226 | 180,371 | 477 | 394,727 |
| Ferrovanadium | 4 | 14,331 | ..... | ..... | (b) | 3,770 |
| Ferromanganese | 59,254 | 7,775,278 | 9,077 | 888,419 | 95,007 | 6,125,469 |
| Spiegeleisen | 5,234 | 277,900 | 307 | 10,472 | 8,151 | 268,135 |
| | 81,051 | 10,397,896 | 17,927 | 1,576,131 | 118,841 | 7,789,632 |

[a] 345 pounds. [b] 1,160 pounds.

*Ferromanganese and ferrosilicon imported into the United States, 1920-1922, by countries.*

[General imports.]

| Country. | Alloy. | 1920 | | 1921 | | 1922 | |
|---|---|---|---|---|---|---|---|
| | | Gross tons. | Value. | Gross tons. | Value. | Gross tons. | Value. |
| Belgium | Ferrosilicon | | | | | 31 | $1,246 |
| Brazil | Ferromanganese | 465 | $98,208 | | | | |
| British India | do | 1,977 | 336,908 | | | | |
| Canada | do | 203 | 16,106 | 16 | $2,059 | 90 | 6,166 |
| | Ferrosilicon | 13,885 | 715,449 | 7,409 | 363,702 | 12,963 | 755,326 |
| England | Ferromanganese | 56,128 | 7,242,252 | 8,802 | 873,198 | 93,038 | 5,988,932 |
| | Ferrosilicon | 19 | 3,833 | | | 850 | 49,953 |
| France | Ferromanganese | | | | | 40 | 8,393 |
| | Ferrosilicon | 5 | 164 | 77 | 7,670 | | |
| Germany | Ferromanganese | | | 235 | 12,057 | 955 | 57,027 |
| | Ferrosilicon | | | 107 | 3,353 | | |
| Japan | Ferromanganese | 480 | 81,455 | | | | |
| Netherlands | do | | | | | 500 | 30,615 |
| Norway | do | | | | | 25 | 1,483 |
| | Ferrosilicon | | | | | 649 | 24,380 |
| Scotland | Ferromanganese | 1 | 349 | | | | |
| Sweden | do | | | 24 | 1,105 | 5 | 1,800 |
| | Ferrosilicon | | | 255 | 12,029 | | |
| Switzerland | Ferromanganese | | | | | 5 | 562 |
| | Ferrosilicon | | | 10 | 1,666 | | |

*Ferroalloys exported from the United States, 1920–1922.*

| Variety of alloy. | 1920 | | 1921 | | 1922 | |
|---|---|---|---|---|---|---|
| | Gross tons. | Value. | Gross tons. | Value. | Gross tons. | Value. |
| Ferromanganese | 3,454 | $642,570 | 690 | $100,474 | 1,107 | $76,822 |
| Spiegeleisen | (a) | (a) | (a) | (a) | 289 | 7,740 |
| Ferrochrome and chrome metal | (a) | (a) | (a) | (a) | 23 | 1,941 |
| Ferrosilicon | 632 | 41,057 | 368 | 20,204 | 689 | 30,939 |
| Tungsten and ferrotungsten | 2 | 5,913 | | | (b) | 43,219 |
| Ferrovanadium | 173 | 705,385 | 98 | 424,886 | 22 | 69,279 |

a Not separately classified prior to Jan. 1, 1922.
b 1,009 pounds.

## STEEL.

### PRODUCTION.

The following tables showing the production of steel were compiled by the American Iron and Steel Institute. No data whatever are available on the value of the output of crude steel at the mills, but the weekly issues and annual statistical reviews of the Iron Age give market quotations of prices of steel billets and some of the leading forms of finished steel. Prices of the principal items remained nearly the same in 1921 and 1922. The price of Bessemer steel billets at Pittsburgh in 1922 ranged from $28 to $40 a gross ton; in 1921 it ranged from $29 to $43.50. Tank plates at Pittsburgh ranged from 1.39 to 2.13 cents a pound in 1922 and from 1.50 to 2.65 cents in 1921. Steel beams at Pittsburgh ranged from 1.39 to 2 cents a pound in 1922 and from 1.50 to 2.45 cents in 1921.

*Bessemer steel ingots and castings manufactured in the United States, 1918–1922, in gross tons.*

| State. | 1918 | 1919 | 1920 | 1921 | 1922 |
|---|---|---|---|---|---|
| Ohio | 3,920,442 | 3,073,941 | 3,662,718 | 1,581,610 | 2,324,425 |
| Pennsylvania | 3,281,941 | 2,851,402 | 3,279,023 | 1,665,456 | 2,474,956 |
| Illinois | 1,229,568 | 906,324 | 1,243,837 | 532,539 | 707,067 |
| Other States | 944,285 | 439,895 | 697,509 | 236,333 | 412,850 |
| | 9,376,236 | 7,271,562 | 8,883,087 | 4,015,938 | 5,919,298 |

*Open-hearth steel ingots and castings manufactured in the United States, 1918–1922, in gross tons.*

| State. | 1918 | 1919 | 1920 | 1921 | 1922 |
|---|---|---|---|---|---|
| New England States | 329,630 | 286,826 | 290,967 | 102,642 | 204,343 |
| New York and New Jersey | 2,245,239 | 1,296,005 | 2,010,895 | 634,290 | 1,597,881 |
| Pennsylvania | 15,574,101 | 12,692,112 | 14,184,477 | 6,408,043 | 11,583,812 |
| Ohio | 6,729,955 | 5,112,616 | 6,341,016 | 3,108,332 | 6,770,293 |
| Indiana | 3,910,899 | 3,122,486 | 3,785,056 | 2,308,414 | 3,571,397 |
| Illinois | 2,283,991 | 1,664,993 | 2,302,776 | 1,093,268 | 2,077,920 |
| Other States | 3,385,576 | 2,773,656 | 3,756,708 | 1,934,813 | 3,503,337 |
| | 34,459,391 | 26,948,694 | 32,671,895 | 15,589,802 | 29,308,983 |

According to these tables there were increases of 47 per cent in the production of Bessemer steel and of 88 per cent in open-hearth steel in 1922 compared with 1921. In the total production of steel there was an increase of 80 per cent. Of the total output in 1922, 82 per cent was represented by open-hearth steel, 17 per cent by Bessemer steel, and 1 per cent by all other classes of steel.

Of the total output of open-hearth steel, 28,387,171 gross tons was made by the basic process and 921,812 tons by the acid process, compared with 15,082,564 tons of basic and 507,238 tons of acid steel in 1921.

The production of steel by the electric process in 1922 showed an increase of 104 per cent as compared with 1921.

*Steel electrically manufactured in the United States, 1909 to 1922, in gross tons.*

| Year. | Ingots. | Castings. | Total. | Year. | Ingots. | Castings. | Total. |
|---|---|---|---|---|---|---|---|
| 1909 | 13,456 | 306 | 13,762 | 1916 | 126,048 | 42,870 | 168,918 |
| 1910 | 50,821 | 1,320 | 52,141 | 1917 | 239,632 | 64,911 | 304,543 |
| 1911 | 27,227 | 1,878 | 29,105 | 1918 | 403,068 | 108,296 | 511,364 |
| 1912 | 14,147 | 4,162 | 18,309 | 1919 | 272,942 | 111,510 | 384,452 |
| 1913 | 20,973 | 9,207 | 30,180 | 1920 | 346,956 | 155,196 | 502,152 |
| 1914 | 15,458 | 8,551 | 24,009 | 1921 | 84,404 | 85,095 | 169,499 |
| 1915 | 46,348 | 23,064 | 69,412 | 1922 | 191,057 | 154,982 | 346,039 |

In the total production of electric steel in 1922 are included 125,419 tons of alloy-steel ingots and castings which were alloyed with nickel, vanadium, tungsten, chromium, molybdenum, and other metals (107,659 tons of ingots and 17,760 tons of castings), compared with 62,618 tons (53,162 tons of ingots and 9,456 tons of castings) so alloyed in 1921.

On December 31, 1922, the number of completed plants equipped for the manufacture of steel by the electric process was 203, as com-

pared with 198 plants at the end of 1921. On January 1, 1922, it was reported that there were 388 electric furnaces of all types in the United States and 50 in Canada, and at the end of the year there were 406 in the United States and 50 in Canada. The total number of furnaces in the world at the beginning and end of 1922 was estimated at 1,000 and 1,175, respectively, as compared with 140 in 1913.[13]

*Steel produced in the United States, 1810–1922, in gross tons.*

| Year. | Bessemer. | Open-hearth. | Crucible. | Other steel. | Total. |
|---|---|---|---|---|---|
| 1810–1870 | 58,482 | 2,232 | 146,370 | | 207,084 |
| 1871 | 40,179 | 1,785 | 31,250 | | 73,214 |
| 1872–1880 | 4,293,896 | 245,035 | 349,730 | 76,009 | 4,964,670 |
| 1881–1890 | 21,596,699 | 2,387,925 | 703,489 | 37,044 | 24,725,157 |
| 1891–1900 | 49,387,341 | 15,392,764 | 762,446 | 35,820 | 65,578,371 |
| 1901–1910 | 94,048,698 | 92,418,814 | 1,051,379 | 154,683 | 187,673,574 |
| 1911–1915 | 42,329,520 | 98,833,090 | 544,047 | 185,692 | 141,892,349 |
| 1916 | 11,059,039 | 31,415,427 | 129,692 | 169,522 | 42,773,680 |
| 1917 | 10,479,960 | 34,148,893 | 126,716 | 305,038 | 45,060,607 |
| 1918 | 9,376,236 | 34,459,391 | 115,112 | 511,693 | 44,462,432 |
| 1919 | 7,271,562 | 26,948,694 | 63,572 | 387,404 | 34,671,232 |
| 1920 | 8,883,087 | 32,671,895 | 72,265 | 505,687 | 42,132,934 |
| 1921 | 4,015,938 | 15,589,802 | 7,613 | 170,444 | 19,783,797 |
| 1922 | 5,919,298 | 29,308,983 | 28,606 | 346,039 | 35,602,926 |

## FOREIGN TRADE IN STEEL.

According to available records the value of the steel and iron imported in 1922 showed an increase of nearly 40 per cent as compared with that of 1921, but the exports of steel and iron decreased 14 per cent in quantity and 41 per cent in total value.

*Iron and steel imported into the United States, 1920–1922.*

| Article. | 1920 | | 1921 | | 1922 | |
|---|---|---|---|---|---|---|
| | Gross tons. | Value. | Gross tons. | Value. | Gross tons. | Value. |
| Bar iron | 4,987 | $677,182 | 1,913 | $203,486 | 8,092 | $516,380 |
| Boiler and other plate of iron and steel | (a) | (a) | (a) | (a) | b 1,141 | b 42,003 |
| Iron and steel scrap | 140,645 | 2,915,589 | 41,469 | 479,800 | 142,969 | 1,841,375 |
| Rails for railway | 45,684 | 1,922,409 | 22,048 | 847,122 | 26,629 | 886,569 |
| Sheets of iron or steel, skelps, sawplates and steel | (a) | (a) | (a) | (a) | b 380 | b 52,470 |
| Sheets and plates | 1,792 | 589,199 | 1,976 | 301,423 | c 426 | c 91,048 |
| Steel ingots, bars, etc | 24,233 | 4,892,600 | 10,024 | 1,290,404 | 27,720 | 2,597,382 |
| Tin and terne plates | 400 | 130,143 | 455 | 122,880 | 2,682 | 309,255 |
| Wire and articles made from wire | ..... | 1,440,813 | ..... | 1,259,811 | ..... | 1,467,556 |
| Wire rods | 5,488 | 746,953 | 917 | 115,942 | 1,735 | 150,980 |
| All other manufactures—free | ..... | 2,141,874 | ..... | 231,526 | ..... | c 364,773 |
| All other manufactures—dutiable | ..... | 7,624,326 | ..... | 6,201,847 | ..... | 7,135,199 |
| | ..... | 23,081,088 | ..... | 11,054,241 | ..... | 15,457,990 |

a Not separately classified prior to Sept. 22, 1922.
b September 22 to December 31.
c January 1 to September 21.

[13] Cone, E. F., Electric steel industry after ten years: Iron Age, Jan. 4, 1923, pp. 80–83.

*Iron and steel exported from the United States, 1920–1922.*

| Article. | 1920 | | 1921 | | 1922 | |
|---|---|---|---|---|---|---|
| | Gross tons. | Value. | Gross tons. | Value. | Gross tons. | Value. |
| Axes | ..... | $1,478,935 | ..... | $1,325,374 | ..... | $692,136 |
| Bars or rods (of steel): | | | | | | |
| Wire | 116,775 | 8,884,854 | 18,953 | 1,112,234 | 40,424 | 1,819,504 |
| All other | 629,051 | 53,841,518 | 188,463 | 14,043,840 | 13,897 | 1,487,031 |
| Billets, ingots, blooms, sheet, bar, and skelp | 216,873 | 12,645,950 | 10,071 | 516,498 | 107,334 | 3,986,004 |
| Bolts and nuts | 38,944 | 7,274,411 | 24,230 | 4,884,596 | 18,098 | 2,919,073 |
| Hammers and hatchets | ..... | 1,303,185 | ..... | 651,341 | ..... | 247,971 |
| Hoops and bands | 53,449 | 6,445,155 | 22,274 | 2,013,798 | 34,512 | 2,742,947 |
| Horseshoes | 1,834 | 260,583 | 615 | 109,444 | 987 | 164,461 |
| Horseshoe nails | (b) | (b) | (b) | (b) | 795 | 241,279 |
| Iron and mild steel, not containing alloys [a] | 46,628 | 4,651,224 | 12,338 | 1,190,669 | 171,356 | 8,960,726 |
| Iron and steel scrap | 219,250 | 6,411,534 | 37,592 | 580,023 | 64,784 | 996,507 |
| Nails: | | | | | | |
| Cut nails | 3,858 | 573,990 | 1,094 | 133,629 | 3,509 | 283,360 |
| Wire nails | 93,179 | 11,880,398 | 28,109 | 3,192,054 | 55,022 | 4,127,136 |
| All other, including tacks | 12,435 | 3,068,120 | 4,691 | 1,178,064 | 4,053 | 1,064,137 |
| Radiators and cast-iron house-heating boilers | 7,336 | 1,337,032 | 3,408 | 575,427 | 5,413 | 911,499 |
| Rails for railways, of steel | 594,628 | 36,193,689 | 321,822 | 18,395,580 | 277,090 | 10,833,210 |
| Railroad spikes | 16,601 | 1,607,672 | 8,164 | 908,755 | 7,895 | 530,754 |
| Railroad-track material, switches, frogs, fishplates, splices, bars, etc. | ..... | 7,570,236 | ..... | 6,461,731 | 30,402 | 2,868,524 |
| Saws | ..... | 4,455,639 | ..... | 2,358,243 | ..... | 606,171 |
| Sheets and plates: | | | | | | |
| Galvanized | 108,368 | 16,727,590 | 56,085 | 7,754,843 | 109,320 | 10,191,841 |
| Iron | 32,157 | 4,036,239 | 12,414 | 1,578,055 | 15,389 | 689,062 |
| Shovels and spades | ..... | 1,294,291 | ..... | 561,432 | ..... | 393,133 |
| Steel: | | | | | | |
| Plates, not fabricated | 920,059 | 72,995,717 | 335,868 | 23,285,080 | 69,693 | 3,057,443 |
| Sheets, black | 169,244 | 21,199,524 | 193,433 | 18,732,662 | 214,911 | 15,899,934 |
| Structural iron and steel | 493,633 | 38,384,690 | 297,022 | 26,824,258 | 167,585 | 9,672,927 |
| Tin and terne plates | 226,410 | 40,545,291 | 107,714 | 17,415,152 | 76,633 | 7,950,473 |
| Tubular products and fittings: | | | | | | |
| Boiler tubes | (b) | (b) | (b) | (b) | 12,073 | 1,552,354 |
| Wrought pipes and fittings | 284,771 | 43,774,296 | 345,376 | 48,953,189 | (c) | (c) |
| Casings and oil-line pipes | (b) | (b) | (b) | (b) | 51,726 | 4,517,507 |
| Welded black pipes | (b) | (b) | (b) | (b) | 75,073 | 6,040,936 |
| Welded galvanized pipes | (b) | (b) | (b) | (b) | 32,519 | 3,228,290 |
| Malleable-iron pipe fittings | (b) | (b) | (b) | (b) | 7,848 | 1,839,274 |
| Cast pipe and fittings | 68,417 | 9,753,446 | 48,645 | 7,265,747 | (c) | (c) |
| Cast-iron pipe | (b) | (b) | (b) | (b) | 18,001 | 1,340,693 |
| Cast-iron pipe fittings | (b) | (b) | (b) | (b) | 9,301 | 2,010,651 |
| Wire: | | | | | | |
| Barbed | 129,710 | 16,056,346 | 29,976 | 3,558,691 | 70,828 | 5,475,578 |
| All other | 190,969 | 25,371,776 | 69,336 | 8,726,123 | 113,151 | 8,342,122 |
| All other tools | ..... | 16,945,325 | ..... | 8,354,163 | ..... | 9,774,096 |
| | ..... | 476,968,656 | ..... | 232,640,695 | ..... | 137,458,744 |

[a] Bar iron prior to Jan. 1, 1922.
[b] Not separately classified prior to Jan. 1, 1922.
[c] Various classes shown separately beginning Jan. 1, 1922.

# GOLD, SILVER, COPPER, LEAD, AND ZINC IN UTAH.

(MINES REPORT.)

By V. C. Heikes.[1]

## PRODUCTION.

The output of ores of gold, silver, copper, lead, and zinc in 1922 from mines in Utah was more than double that of 1921, and the quantity and value of all metals increased considerably. The published dividends paid by 11 producers in 1922 amounted to $4,999,552, which gives a total paid to stockholders since mining became profitable of $231,598,985.

*Mine production of gold, silver, copper, lead, and zinc in Utah in 1921–22.*

| Year. | Number of producers. | Ore. | Gold.[a] | Silver.[a] | Copper. | Lead. | Recoverable zinc. | Total value. |
|---|---|---|---|---|---|---|---|---|
| | | *Short tons.* | | *Fine ounces.* | *Pounds.* | *Pounds.* | *Pounds.* | |
| 1921 | 138 | 2,137,522 | $1,769,905 | 12,251,998 | 30,891,403 | 89,187,269 | 69,390 | $22,023,790 |
| 1922 | 154 | 5,560,034 | 2,296,855 | 17,271,100 | 97,193,850 | 135,332,144 | 5,119,410 | 40,424,199 |
| Increase, 1922 | 16 | 3,422,512 | 526,950 | 5,019,102 | 66,302,447 | 46,144,875 | 5,050,020 | 18,400,409 |
| 1864–1922[b] | | | 104,309,290 | 433,756,159 | 2,558,410,341 | 4,631,794,958 | 228,134,589 | 1,159,564,585 |

[a] Includes small placer production.
[b] The total by years to the end of 1917 appears in U. S. Geol. Survey Prof. Paper 111, p. 127, 1920.

## THE TREND OF MINING IN UTAH.

The early history of the mining industry in Utah deals with the discovery of ore in 1859 in a portion of Utah which is now included in Nevada. At the same time an attempt was made in Beaver County to reduce lead ore to bullion. Metalliferous deposits were located in the vicinity of Salt Lake City on September 17, 1863. From that time discoveries and locations were made rapidly. In 1865 and for several years thereafter the production of gold from the placers in Bingham Canyon amounted to about a million dollars annually. These deposits were then practically exhausted, and since then no large deposits of placer gold have been found in any other district of Utah. In 1870 the production from the lead-silver deposits of the State became important. Since that time, except for a few temporary depressions, the increase in the metal output has been

[1] Valuable assistance in the preparation of this report and the compilation of statistical tables was rendered by B. N. Patchell, of the United States Geological Survey.

steady. In the early days metallurgical plants were generally situated near the mines. These plants consisted mainly of mills for the treatment of the silver ores and of crude smelters for the reduction of the oxidized lead ores. Later the plants were more centralized, and ore from the mining districts was treated at two or three large smelters. When the rich oxidized ores were exhausted it became necessary to erect mills at or near the mines to concentrate the metallic constituents and in some ores to separate the different metallic minerals, which were then sent to the smelters for reduction. Such mills have been erected in the Park City, Bingham, and other districts. In recent years the development of large bodies of low-grade copper ore in the Bingham district has resulted in the erection of the large concentration mills near Garfield, where more than 40,000 tons of ore can be milled daily.

In the treatment of gold ore Utah was a pioneer in developing the cyanide process, which transformed the operations of the Mercur camp from a forlorn hope to an important commercial enterprise. At present most of the ore and concentrate produced by the mines in Utah is treated at four smelting plants near Salt Lake City, but most of the zinc ore and concentrate, which for a short period was considerable in quantity, is still shipped out of the State for final treatment. Large reserves of lead-zinc ore exist both at Park City and at Bingham, but the rate charged for electric power precludes the operation of electrolytic zinc plants in Utah.

Utah has been a large producer of silver since 1901. The largest output was that of 1922, when 17,271,000 ounces was produced. The gold output, valued at $1,373,000 in 1895, rose to $5,218,000 in 1906 and has since decreased to $2,297,000 in 1922. Though the output of gold from ores treated by amalgamation or cyanidation was notable in the earlier years, at present most of the gold is recovered from copper ore or lead ore. The output of lead increased from 10,000,000 pounds in 1871 to 107,000,000 pounds in 1902, reached a maximum output of 201,490,000 pounds in 1916, and then steadily decreased to 135,332,000 pounds in 1922. From 1904 to the end of 1922 the property of the Utah Copper Co. at Bingham produced about 696,000,000 pounds of copper, compared with the total of about 2,558,000,000 pounds for the State since 1870, when copper became important. The largest copper production was that of 1917, when the mines of Utah produced 246,674,000 pounds.

The following tables give the production of the State in the last 13 years and a separation by kinds of ore. The increase of silver and lead in siliceous and dry ores is notable. Since the World War there has been a marked decrease in the production of copper ores, but a slight recovery was recorded in 1922. The mining of lead ore has been affected by litigation among the largest producers in the last four years, but some improvement was noted in 1922. Copper-lead ore is confined to a few districts, and the production of this class of ore is erratic. Zinc ore and lead-zinc ore reached the highest output during the war period and declined seriously in the last three years. These ores occur in great quantity at Park City and Bingham, and they will probably be treated by some cheap method in the future.

*Mine production of gold, silver, copper, lead, and zinc in Utah, 1910–1922.*

| Year. | Ore sold or treated. | Gold.[a] | Silver.[a] | Copper. | Lead. | Zinc. | Total value. |
|---|---|---|---|---|---|---|---|
| | *Short tons.* | *Fine ounces.* | *Fine ounces.* | *Pounds.* | *Pounds.* | *Pounds.* | |
| 1910 | 6,389,398 | 195,052.11 | 10,466,971 | 127,597,072 | 123,324,635 | 16,367,104 | $32,199,185 |
| 1911 | 7,268,530 | 227,217.28 | 12,473,787 | 146,960,827 | 136,496,750 | 17,840,261 | 36,837,457 |
| 1912 | 7,770,270 | 206,360.54 | 13,835,903 | 137,307,485 | 140,311,135 | 17,067,177 | 42,922,302 |
| 1913 | 10,202,566 | 172,467.95 | 13,084,835 | 161,445,962 | 166,126,790 | 18,857,827 | 44,858,210 |
| 1914 | 8,544,014 | 157,961.16 | 11,154,916 | 152,034,002 | 171,323,137 | 15,989,267 | 37,151,593 |
| 1915 | 10,451,445 | 174,590.65 | 12,313,205 | 187,671,188 | 199,967,437 | 24,292,240 | 55,105,070 |
| 1916 | 13,920,643 | 172,938.06 | 13,253,037 | 240,275,222 | 201,490,075 | 29,572,528 | 89,268,684 |
| 1917 | 15,358,481 | 162,305.67 | 13,479,133 | 246,674,153 | 178,521,958 | 21,286,871 | 99,328,155 |
| 1918 | 14,705,718 | 142,666.10 | 13,455,597 | 227,169,630 | 167,008,224 | 18,399,417 | 86,047,597 |
| 1919 | 6,745,423 | 104,464.41 | 11,649,961 | 124,061,807 | 123,829,051 | 4,431,024 | 45,169,328 |
| 1920 | 6,800,180 | 97,454.15 | 13,106,976 | 116,931,238 | 140,838,113 | 8,157,739 | 49,744,334 |
| 1921 | 2,137,522 | 85,619.15 | 12,251,998 | 30,891,403 | 89,187,269 | 69,390 | 22,023,790 |
| 1922 | 5,560,034 | 111,110.36 | 17,271,100 | 97,193,850 | 135,332,144 | 5,119,410 | 40,424,199 |
| | 115,854,224 | 2,010,207.59 | 167,797,419 | 1,996,213,839 | 1,973,756,718 | 197,450,255 | 681,079,904 |

[a] Includes small placer production.

*Content of ore sold or treated in Utah, 1910–1922.*

**Dry and siliceous ore.**

| Year. | Ore. | Gold. | Silver. | Copper. | Lead. | Recoverable zinc. |
|---|---|---|---|---|---|---|
| | *Short tons.* | *Fine ounces.* | *Fine ounces.* | *Pounds.* | *Pounds.* | *Pounds.* |
| 1910 | 391,568 | 47,216.85 | 548,498 | 1,029,927 | 522,046 | ..... |
| 1911 | 464,229 | 78,912.69 | 2,569,157 | 3,259,690 | 2,757,084 | ..... |
| 1912 | 369,736 | 71,243.22 | 3,486,562 | 3,373,103 | 1,809,989 | ..... |
| 1913 | 238,901 | 32,830.03 | 2,027,542 | 1,466,398 | 1,083,039 | ..... |
| 1914 | 149,902 | 18,274.43 | 1,317,364 | 2,020,504 | 814,047 | ..... |
| 1915 | 61,976 | 9,248.67 | 1,035,712 | 687,998 | 1,015,806 | ..... |
| 1916 | 89,363 | 9,122.41 | 1,153,993 | 1,426,917 | 246,028 | ..... |
| 1917 | 164,057 | 20,394.61 | 2,340,537 | 2,579,070 | 976,227 | ..... |
| 1918 | 227,356 | 22,815.44 | 3,987,068 | 3,189,201 | 1,214,547 | ..... |
| 1919 | 239,688 | 25,216.63 | 3,645,909 | 2,758,479 | 1,438,014 | ..... |
| 1920 | 291,020 | 33,347.99 | 3,955,771 | 2,116,803 | 6,282,276 | ..... |
| 1921 | 376,472 | 29,554.10 | 6,088,635 | 1,371,654 | 8,735,063 | ..... |
| 1922 | 414,339 | 38,353.62 | 8,110,733 | 2,635,080 | 8,693,250 | ..... |
| | 3,478,607 | 436,530.69 | 40,267,481 | 27,914,824 | 35,587,416 | ..... |

**Copper ore.**

| | | | | | | |
|---|---|---|---|---|---|---|
| 1910 | 5,417,558 | 113,978.49 | 2,036,909 | 122,306,847 | 222,127 | ..... |
| 1911 | 6,121,099 | 117,247.94 | 2,377,946 | 139,382,161 | 338,688 | ..... |
| 1912 | 6,670,845 | 105,720.03 | 2,542,381 | 127,712,169 | 2,194,024 | ..... |
| 1913 | 9,070,740 | 100,093.39 | 2,314,348 | 152,137,467 | 167,227 | 94,564 |
| 1914 | 7,578,220 | 97,955.32 | 1,726,230 | 142,988,221 | 2,179 | ..... |
| 1915 | 9,436,450 | 101,247.86 | 2,065,661 | 177,784,460 | 20,401 | ..... |
| 1916 | 12,676,152 | 113,396.52 | 2,633,402 | 229,960,014 | 6,540 | ..... |
| 1917 | 14,121,671 | 94,844.85 | 2,225,119 | 235,899,850 | 14,872 | ..... |
| 1918 | 13,512,274 | 75,960.07 | 1,445,559 | 217,252,784 | 2,557 | ..... |
| 1919 | 5,884,118 | 38,873.71 | 586,417 | 116,312,084 | 1,231 | ..... |
| 1920 | 5,778,373 | 31,845.51 | 452,915 | 108,645,375 | 31,461 | ..... |
| 1921 | 1,357,857 | 14,384.74 | 229,556 | 27,321,481 | 255,567 | ..... |
| 1922 | 4,509,384 | 36,398.64 | 473,284 | 91,088,007 | 252,970 | ..... |
| | 102,134,741 | 1,041,947.07 | 21,109,727 | 1,888,790,920 | 3,509,844 | 94,564 |

*Content of ore sold or treated in Utah, 1910–1922*—Continued.

**Lead ore.**

| Year. | Ore. | Gold. | Silver. | Copper. | Lead. | Recoverable zinc. |
|---|---|---|---|---|---|---|
| | *Short tons.* | *Fine ounces.* | *Fine ounces.* | *Pounds.* | *Pounds.* | *Pounds.* |
| 1910 | 329,058 | 28,327.58 | 6,423,523 | 2,818,234 | 85,396,907 | ..... |
| 1911 | 393,079 | 25,709.04 | 6,083,877 | 2,885,369 | 97,494,377 | ..... |
| 1912 | 498,401 | 24,310.76 | 6,212,219 | 4,482,998 | 106,978,033 | 10,608 |
| 1913 | 662,200 | 34,213.80 | 7,537,361 | 6,627,953 | 138,075,527 | 34,222 |
| 1914 | 600,481 | 33,094.69 | 7,350,213 | 6,147,939 | 146,373,700 | 16,341 |
| 1915 | 528,009 | 45,541.34 | 7,759,842 | 7,135,528 | 151,803,997 | ..... |
| 1916 | 665,217 | 33,535.63 | 8,118,264 | 7,212,843 | 159,260,831 | ..... |
| 1917 | 638,071 | 27,115.49 | 7,490,650 | 6,256,268 | 137,245,961 | ..... |
| 1918 | 527,759 | 20,225.49 | 6,672,725 | 4,843,721 | 113,517,267 | ..... |
| 1919 | 435,541 | 17,555.14 | 6,664,219 | 4,157,256 | 95,881,706 | ..... |
| 1920 | 559,896 | 18,185.95 | 7,895,007 | 4,961,482 | 111,133,846 | ..... |
| 1921 | 401,429 | 41,628.44 | 5,893,497 | 2,088,255 | 79,519,436 | 69,390 |
| 1922 | 507,450 | 17,853.25 | 8,183,741 | 2,945,328 | 107,416,311 | ..... |
| | 6,746,591 | 367,296.60 | 92,285,138 | 62,563,174 | 1,530,097,899 | 130,561 |

**Copper-lead ore.**

| | | | | | | |
|---|---|---|---|---|---|---|
| 1910 | 14,982 | 154.63 | 223,108 | 578,250 | 4,451,792 | ..... |
| 1911 | 3,553 | 114.16 | 83,972 | 317,359 | 796,237 | ..... |
| 1912 | 5,102 | 171.58 | 154,091 | 355,779 | 941,532 | ..... |
| 1913 | 2,794 | 70.58 | 105,286 | 254,773 | 926,422 | ..... |
| 1914 | 1,183 | 78.17 | 37,216 | 101,794 | 272,376 | ..... |
| 1915 | 5,329 | 65.89 | 71,497 | 354,162 | 911,594 | ..... |
| 1916 | 9,645 | 421.68 | 145,439 | 559,954 | 1,696,276 | ..... |
| 1917 | 6,443 | 92.25 | 93,296 | 393,079 | 1,436,782 | ..... |
| 1918 | 7,495 | 118.96 | 106,377 | 219,476 | 1,125,021 | ..... |
| 1919 | 1,924 | 32.56 | 38,936 | 125,645 | 746,640 | ..... |
| 1920 | 6,389 | 223.78 | 172,401 | 407,397 | 2,155,329 | ..... |
| 1921 | 1,764 | 31.84 | 40,309 | 110,013 | 677,203 | ..... |
| 1922 | 1,272 | 35.14 | 20,919 | 125,233 | 137,399 | ..... |
| | 67,875 | 1,611.22 | 1,292,847 | 3,902,914 | 16,274,603 | ..... |

**Zinc ore and lead-zinc ore.**

| | | | | | | |
|---|---|---|---|---|---|---|
| 1910 | 236,232 | 5,182.03 | 1,234,908 | 863,814 | 32,731,763 | 16,367,104 |
| 1911 | 286,570 | 4,960.91 | 1,358,802 | 1,116,248 | 35,110,364 | 17,840,261 |
| 1912 | 226,186 | 4,640.18 | 1,440,604 | 1,383,436 | 28,387,557 | 17,056,569 |
| 1913 | 227,931 | 5,167.27 | 1,100,285 | 959,371 | 25,874,575 | 18,729,041 |
| 1914 | 214,228 | 8,499.00 | 723,884 | 775,544 | 23,860,835 | 15,972,926 |
| 1915 | 419,681 | 18,440.55 | 1,380,489 | 1,709,040 | 46,215,639 | 24,292,240 |
| 1916 | 480,266 | 16,401.35 | 1,201,937 | 1,115,494 | 40,280,400 | 29,572,528 |
| 1917 | 428,239 | 19,853.05 | 1,329,531 | 1,545,886 | 38,848,116 | 21,286,871 |
| 1918 | 430,834 | 23,479.96 | 1,243,853 | 1,664,448 | 51,148,832 | 18,399,417 |
| 1919 | 184,152 | 22,786.37 | 714,480 | 708,343 | 25,761,460 | 4,431,024 |
| 1920 | 164,502 | 13,829.01 | 630,875 | 800,181 | 21,235,201 | 8,157,739 |
| 1921 | ..... | ..... | ..... | ..... | ..... | ..... |
| 1922 | 127,589 | 18,366.67 | 482,417 | 400,202 | 18,832,214 | 5,119,410 |
| | 3,426,410 | 161,606.35 | 12,842,065 | 13,042,007 | 388,286,956 | 197,225,130 |

## ORE.

Of the various kinds of ore mined in Utah in 1922 copper ore was mined in greatest quantity, followed by the lead-silver ores and the dry and siliceous ores of silver. The total value of the ores, not shown in the accompanying table, was as follows: Dry gold ore, $549,754; dry gold and silver ore $96,511; dry silver ore, $9,091,173; copper ore, $13,536,505; lead ore, $14,858,316; zinc ore, $27,328; copper-lead ore, $46,109, and lead-zinc ore, $2,216,367. The small placer output, valued at $2,136, makes the total for the State $40,424,199.

*Ore and metals produced in Utah in 1922.*

| Source of production. | Ore. | | Gold. | | Silver. | |
|---|---|---|---|---|---|---|
| | Short tons. | Per cent. | Fine ounces. | Per cent. | Fine ounces. | Per cent. |
| Dry gold ore | 36,624 | 0.66 | 15,924.48 | 14.33 | 173,871 | 1.01 |
| Dry gold and silver ore | 4,145 | .07 | 2,178.47 | 1.96 | 34,141 | .20 |
| Dry silver ore | 373,570 | 6.72 | 20,250.67 | 18.23 | 7,902,721 | 45.76 |
| Copper ore | 4,509,384 | 81.10 | 36,398.64 | 32.76 | 473,284 | 2.74 |
| Lead ore | 507,450 | 9.13 | 17,853.25 | 16.07 | 8,183,741 | 47.38 |
| Zinc ore | 1,578 | .03 | | | | |
| Copper-lead ore | 1,272 | .02 | 35.14 | .03 | 20,919 | .12 |
| Lead-zinc ore | 126,011 | 2.27 | 18,366.67 | 16.53 | 482,417 | 2.79 |
| Total deep mines | 5,560,034 | 100.00 | 111,007.32 | 99.91 | 17,271,094 | 100.00 |
| Total placer mines | | | 103.04 | .09 | 6 | |
| Total, deep and placers, 1922 | 5,560,034 | 100.00 | 111,110.36 | 100.00 | 17,271,100 | 100.00 |
| Total, deep and placers, 1921 | 2,137,522 | | 85,619.15 | | 12,251,998 | |
| Increase, 1922 | 3,422,512 | | 25,491.21 | | 5,019,102 | |

| Source of production. | Copper. | | Lead. | | Zinc. | |
|---|---|---|---|---|---|---|
| | Pounds. | Per cent. | Pounds. | Per cent. | Pounds. | Per cent. |
| Dry gold ore | 84,489 | 0.09 | 641,627 | 0.47 | | |
| Dry gold and silver ore | 121,002 | .12 | 18,210 | .01 | | |
| Dry silver ore | 2,429,589 | 2.50 | 8,033,413 | 5.94 | | |
| Copper ore | 91,088,007 | 93.72 | 252,970 | .19 | | |
| Lead ore | 2,945,328 | 3.03 | 107,416,311 | 79.37 | | |
| Zinc ore | | | | | 479,449 | 9.37 |
| Copper-lead ore | 125,233 | .13 | 137,399 | .10 | | |
| Lead-zinc ore | 400,202 | .41 | 18,832,214 | 13.92 | 4,639,961 | 90.63 |
| Total deep mines, 1922 | 97,193,850 | 100.00 | 135,332,144 | 100.00 | 5,119,410 | 100.00 |
| Total deep mines, 1921 | 30,891,403 | | 89,187,269 | | 69,390 | |
| Increase, 1922 | 66,302,447 | | 46,144,875 | | 5,050,020 | |

## GOLD ORE.

The output of gold ore by four producers was valued at $549,754. It averaged 0.44 ounce of gold and 4.75 ounces of silver to the ton, 0.11 per cent of copper, and 0.88 per cent of lead. The total average value of all metals was $15.01 a ton. Most of the gold ore was mined from the Deer Trail mine, near Marysvale.

*Content of dry gold ores sold or treated in Utah in 1922.*

| County. | Ore. | Gold. | Silver. | Copper. | Lead. |
|---|---|---|---|---|---|
| | *Short tons.* | *Fine ounces.* | *Fine ounces.* | *Pounds.* | *Pounds.* |
| Iron | 1 | 2.00 | 2 | | |
| Piute | 33,247 | 15,431.00 | 171,170 | 15,210 | 639,334 |
| Salt Lake | 3,333 | 217.48 | 2,527 | 69,279 | 1,433 |
| Tooele | 43 | 274.00 | 172 | | 860 |
| | 36,624 | 15,924.48 | 173,871 | 84,489 | 641,627 |

## SILVER ORE.

The dry and siliceous silver ores were mined by 46 producers in 1922, against 40 producers in 1921. These ores averaged $1.12 in gold, 21.15 ounces of silver, 6.50 pounds of copper, and 21.50 pounds of lead to the ton. The Tintic district, in Juab and Utah counties, had the largest number of silver-ore producers—28, who reported

211,111 dry tons—and 21 of these producers shipped 115,738 tons to chloridizing-roasting plants in the district at Silver City and Warm Springs. The largest producers of silver ore in the Tintic district were the Tintic Standard and Chief Consolidated mines, at Park City the Park-Utah and Ontario mines, in Box Elder County the Vipont Silver mine, and at Bingham the Dalton & Lark mine (Bingham Mines Co.).

*Content of dry silver ores sold or treated in Utah in 1922.*

| County. | Ore. | Gold. | Silver. | Copper. | Lead. |
|---|---|---|---|---|---|
| | *Short tons.* | *Fine ounces.* | *Fine ounces.* | *Pounds.* | *Pounds.* |
| Beaver | 1,414 | 17.36 | 16,013 | 4,564 | 12,657 |
| Box Elder | 63,710 | 2,965.04 | 1,038,965 | 21,600 | 123,300 |
| Juab | 116,573 | 11,012.48 | 2,550,165 | 1,336,865 | 2,690,674 |
| Sevier | 7 | 1.47 | 65 | ..... | ..... |
| Salt Lake | 22,897 | 1,017.39 | 94,651 | 298,465 | 541,633 |
| Summit | 31,508 | 1,118.60 | 595,551 | 265,574 | 2,028,699 |
| Tooele | 100 | 1.01 | 2,165 | 622 | 4,329 |
| Utah | 94,538 | 733.04 | 1,451,123 | 318,539 | 1,726,948 |
| Wasatch | 42,807 | 3,383.63 | 2,153,543 | 183,360 | 905,173 |
| Washington | 16 | .65 | 480 | ..... | ..... |
| | 373,570 | 20,250.67 | 7,902,721 | 2,429,589 | 8,033,413 |

## COPPER AND COPPER-LEAD ORES.

Copper ore from 26 producers represented 81 per cent of the total ore output of the State. The average content of this ore was 0.008 ounce of gold, 0.10 ounce of silver, and 20.20 pounds of copper, and the average value was $3 a ton. Salt Lake County was credited with the largest output in 1922, chiefly from the Utah Copper property, at Bingham.

The small quantity of copper-lead ore produced averaged 0.03 ounce of gold and 16.45 ounces of silver to the ton, 4.92 per cent of copper, and 5.40 per cent of lead and was valued at $36.25 a ton. This ore came from the Little Cottonwood, American Fork, and Ophir districts.

*Content of copper ores sold or treated in Utah in 1922.*

| County. | Ore. | Gold. | Silver. | Copper. | Lead. |
|---|---|---|---|---|---|
| | *Short tons.* | *Fine ounces.* | *Fine ounces.* | *Pounds.* | *Pounds.* |
| Box Elder | 23 | ..... | 15 | 6,598 | ..... |
| Grand | 10 | ..... | 402 | 885 | ..... |
| Iron | 3 | ..... | 6 | 1,498 | 20 |
| Juab | 3,080 | 1,322.93 | 56,248 | 172,001 | 53,027 |
| Salt Lake | 4,506,096 | 34,791.76 | 415,143 | 90,881,041 | 199,337 |
| Tooele | 24 | 2.00 | 746 | 3,475 | 585 |
| Utah | 148 | 281.95 | 724 | 22,509 | ..... |
| | 4,509,384 | 36,398.64 | 473,284 | 91,088,007 | 252,970 |

*Content of copper-lead ores sold or treated in Utah in 1922.*

| County. | Ore. | Gold. | Silver. | Copper. | Lead. |
|---|---|---|---|---|---|
| | *Short tons.* | *Fine ounces.* | *Fine ounces.* | *Pounds.* | *Pounds.* |
| Salt Lake | 1,080 | 31.43 | 17,450 | 122,381 | 123,577 |
| Tooele | 27 | 2.94 | 998 | 1,502 | 8,622 |
| Utah | 165 | .77 | 2,471 | 1,350 | 5,200 |
| | 1,272 | 35.14 | 20,919 | 125,233 | 137,399 |

## LEAD ORE.

The output of lead ore by 102 producers was valued at $14,858,316. It averaged 0.035 ounce of gold and 16.13 ounces of silver to the ton, 0.29 per cent of copper, and 10.58 per cent of lead. The total average value of all the metals was $29.28 a ton. In 1921 there were 100 producers of lead ore, whose output was valued at $10,605,262, or $26.42 a ton.

*Content of lead ores sold or treated in Utah in 1922.*

| County. | Ore. | Gold. | Silver. | Copper. | Lead. |
|---|---|---|---|---|---|
| | *Short tons.* | *Fine ounces.* | *Fine ounces.* | *Pounds.* | *Pounds.* |
| Beaver | 10,119 | 517.00 | 98,562 | 42,139 | 2,351,092 |
| Box Elder | 193 | 11.00 | 4,691 | 537 | 87,010 |
| Iron | 1 | ..... | 2 | ..... | 2,100 |
| Juab | 123,070 | 6,546.96 | 3,698,141 | 181,282 | 33,310,216 |
| Piute | 5,134 | 2,818.74 | 119,178 | 34,223 | 983,650 |
| Salt Lake | 104,059 | 3,305.04 | 666,731 | 748,903 | 24,551,247 |
| Summit | 140,084 | 2,795.59 | 1,680,515 | 531,516 | 20,631,560 |
| Tooele | 56,941 | 195.29 | 337,107 | 771,320 | 7,022,119 |
| Utah | 25,168 | 781.59 | 763,229 | 172,998 | 9,785,156 |
| Wasatch | 42,681 | 882.04 | 815,585 | 462,405 | 8,692,161 |
| | 507,450 | 17,853.25 | 8,183,741 | 2,945,328 | 107,416,311 |

## ZINC ORE AND LEAD-ZINC ORE.

In 1922, with higher metal prices, nine producers sold zinc contained in ore and concentrates. Lead-zinc ore was the source of about 90 per cent of the recoverable zinc, and nearly all of it came from Salt Lake County. One small lot was shipped by a lessee from the Horn Silver mine, in Beaver County, to the Midvale concentrator, where most of the zinc is recovered in concentrate and retreated in an electrostatic zinc separator. The product was sold to different eastern plants in 1922.

Zinc ore, largely from the Tecoma mine, in the Lucin district, with small lots from the Ophir, Rush Valley, and Blue Bell districts, was treated at the oxide plant of the Utah Zinc Co., near Murray. This company operated its oxide plant a few months in 1922 so as to work up the ore on hand.

*Content of zinc ores sold or treated in Utah in 1922.*

| County. | Ore. | Zinc. |
|---|---|---|
| | *Short tons.* | *Pounds.* |
| Box Elder | 1,440 | 411,476 |
| Juab | 43 | 24,022 |
| Tooele | 95 | 43,951 |
| | 1,578 | 479,449 |

*Content of lead-zinc ores sold or treated in Utah in 1922.*

| County. | Ore. | Gold. | Silver. | Copper. | Lead. | Zinc. |
|---|---|---|---|---|---|---|
| | *Short tons.* | *Fine ounces.* | *Fine ounces.* | *Pounds.* | *Pounds.* | *Pounds.* |
| Beaver | 58 | 1.40 | 301 | 67 | 11,997 | 6,375 |
| Salt Lake | 125,953 | 18,365.27 | 482,116 | 400,135 | 18,820,217 | 4,633,586 |
| | 126,011 | 18,366.67 | 482,417 | 400,202 | 18,832,214 | 4,639,961 |

## METALLURGIC INDUSTRY.

### GENERAL FEATURES.

Cyanidation of ores was practiced at the Deer Trail mine, in Piute County, the only property using the process in Utah. The ore is crushed in a 2 per cent cyanide solution and then run over concentrating tables to make a lead product. The tailing from the tables is agitated 48 hours, after which it passes to the filter presses. No amalgamation of gold was reported in 1922.

Of the 20 milling plants operated in 1922 in Utah, 1 was equipped for concentration and cyanidation, 2 were chloridizing-roasting and leaching plants, and 17 were concentration plants. Six of the concentration plants were equipped with tables followed by the oil-flotation process, and three used flotation alone. Six mills used ordinary table concentration, and one of these that was equipped for wet concentration treated the dried concentrate by electrostatic separation. The hydrometallurgy of lead has been used in the experimental stage at Silver City in the chloridizing-roasting plant, which is equipped with Holt-Dern furnaces. If successful this will be the first application of the method of precipitating lead from brine solution by sponge iron. At the Tintic Standard mill, which uses the chloridizing-roasting process, the lead is successfully recovered from solution on detinned scrap after the silver and copper have been previously extracted by the use of scrap iron.

The different kinds of concentrates produced in Utah in 1922, as shown in the following tables, aggregated 315,531 tons and contained 55 per cent of the gold, against 49 per cent in 1921; 16 per cent of the silver, against 14 per cent; 92 per cent of the copper, against 80 per cent; 29 per cent of the lead, against 32 per cent; and 91 per cent of the zinc, against 100 per cent.

*Mine production of gold, silver, copper, lead, and zinc from Utah concentrates in 1922.*

**By counties.**

| County. | Ore to concentrating mills. | Concentrates. | Gold. | Silver. | Copper. | Lead. | Recoverable zinc. | Total value. |
|---|---|---|---|---|---|---|---|---|
| | *Short tons.* | *Short tons.* | *Fine ounces.* | *Fine ounces.* | *Pounds.* | *Pounds.* | *Pounds.* | |
| Beaver | 58 | 25 | 1.40 | 301 | 67 | 11,997 | 6,375 | $1,362 |
| Box Elder | 63,561 | 4,571 | 2,839.59 | 978,228 | 21,600 | 123,300 | ..... | 1,046,620 |
| Juab | 774 | 116 | 6.25 | 9,876 | 1,249 | 79,021 | ..... | 14,519 |
| Piute | 225 | 2,423 | 6,608.44 | 86,279 | 15,792 | 664,263 | ..... | 261,554 |
| Salt Lake | 4,639,779 | 265,719 | 50,183.85 | 872,844 | 88,701,643 | 23,463,107 | 4,633,586 | 15,439,544 |
| Summit | 49,793 | 13,284 | 554.82 | 232,313 | 53,962 | 4,864,762 | ..... | 518,629 |
| Tooele | 54,628 | 21,955 | 109.77 | 306,557 | 756,495 | 5,613,739 | ..... | 719,709 |
| Utah | 165 | 16 | .77 | 2,471 | 1,350 | 5,200 | ..... | 2,955 |
| Wasatch | 29,724 | 7,422 | 441.33 | 248,775 | 117,035 | 4,172,877 | ..... | 503,200 |
| | 4,838,707 | 315,531 | 60,746.22 | 2,737,644 | 89,669,193 | 38,998,266 | 4,639,961 | 18,508,104 |

**By kinds of concentrates.**

| | | | | | | | | |
|---|---|---|---|---|---|---|---|---|
| Dry and siliceous | ..... | 6,613 | 3,057.07 | 980,755 | 90,879 | 124,733 | ..... | $1,063,080 |
| Copper | ..... | 202,801 | 31,228.76 | 309,128 | 88,098,018 | ..... | ..... | 12,847,910 |
| Lead | ..... | 99,998 | 25,849.62 | 1,431,780 | 1,478,946 | 38,427,093 | ..... | 4,279,287 |
| Zinc | ..... | 6,103 | 610.00 | 13,510 | ..... | 441,240 | 4,639,961 | 314,886 |
| Copper-lead | ..... | 16 | .77 | 2,471 | 1,350 | 5,200 | ..... | 2,956 |

*Mine production of gold, silver, copper, lead, and zinc from Utah concentrates in 1922*—Continued.

**Average content.**

| Kind of concentrates. | Concentrates. | Gold. | Silver. | Copper. | Lead. | Recoverable zinc. | Total value. |
|---|---|---|---|---|---|---|---|
| | *Short tons.* | *Fine ounces per ton.* | *Fine ounces per ton.* | *Per cent.* | *Per cent.* | *Per cent.* | |
| Dry and siliceous | 6,613 | 0.46 | 148.31 | 0.69 | 0.94 | ..... | $160.76 |
| Copper | 202,801 | .15 | 1.52 | 21.72 | ..... | ..... | 63.35 |
| Lead | 99,998 | .26 | 14.32 | .74 | 19.21 | ..... | 42.79 |
| Zinc | 6,103 | .10 | 2.21 | ..... | 3.61 | 38.01 | 51.59 |
| Copper-lead | 16 | .05 | 154.44 | 4.22 | 16.25 | ..... | 184.69 |
| | 315,531 | .19 | 8.68 | 14.21 | 6.18 | .74 | 58.66 |

A serious problem with the smelters is that of obtaining an adequate supply of sulphide ores and of cheaper fluxing materials, chiefly iron ore, to treat the excess of the dry and siliceous ores, of which a considerable quantity will continue to be produced from the mines. A solution of the problem may be found by using iron ore from Iron County, which will probably be mined cheaply and delivered to the smelters under a low freight rate. A large output of iron is expected, to meet the demand, and can probably be delivered to the smelters at a total cost of about $3 to $4 a ton. Most of the ore has 40 to 50 per cent excess iron over silica, and with the ordinary charge ratio this is said to treat the average siliceous ore ton for ton.

Crude ore of all kinds shipped directly to the smelters amounted to 497,985 tons, or about 9 per cent of the total output, and produced 36 per cent of the gold in 1922, against 42 per cent in 1921; 75 per cent of the silver, against 76 per cent; 7 per cent of the copper, against 17 per cent; 69 per cent of the lead, against 67 per cent; and 9 per cent of the zinc.

*Mine production of metals from Utah crude ore shipped to smelters in 1922.*

**By counties.**

| County. | Ore. | Gold. | Silver. | Copper. | Lead. | Recoverable zinc. | Total value. |
|---|---|---|---|---|---|---|---|
| | *Short tons.* | *Fine ounces.* | *Fine ounces.* | *Pounds.* | *Pounds.* | *Pounds.* | |
| Beaver | 5,766 | 373.41 | 76,340 | 31,454 | 1,664,253 | ..... | $179,839 |
| Box Elder | 1,805 | 136.45 | 65,443 | 7,135 | 87,010 | 411,476 | 97,466 |
| Grand | 10 | ..... | 402 | 885 | ..... | ..... | 522 |
| Iron | 5 | 2.00 | 10 | 1,498 | 2,120 | ..... | 370 |
| Juab | 212,186 | 20,776.23 | 6,029,248 | 1,722,669 | 35,993,106 | 24,022 | 8,672,281 |
| Piute | 4,910 | 2,811.77 | 118,336 | 33,646 | 958,721 | ..... | 233,733 |
| Salt Lake | 122,448 | 7,534.57 | 802,855 | 3,246,321 | 20,774,337 | ..... | 2,539,450 |
| Sevier | 7 | 1.47 | 65 | ..... | ..... | ..... | 95 |
| Summit | 54,416 | 2,520.98 | 1,880,188 | 580,251 | 16,276,389 | ..... | 2,905,836 |
| Tooele | 2,602 | 365.47 | 34,631 | 20,424 | 1,422,777 | 43,951 | 125,701 |
| Utah | 38,066 | 1,627.00 | 1,212,302 | 344,046 | 10,317,104 | ..... | 1,859,822 |
| Wasatch | 55,764 | 3,824.34 | 2,720,353 | 528,730 | 5,424,457 | ..... | 3,169,133 |
| | 497,985 | 39,973.69 | 12,940,173 | 6,517,059 | 92,920,274 | 479,449 | 19,784,248 |

**By kinds of ore.**

| | | | | | | | |
|---|---|---|---|---|---|---|---|
| Dry and siliceous | 176,714 | 18,588.77 | 5,488,439 | 2,106,925 | 5,303,896 | ..... | $6,448,852 |
| Copper | 37,669 | 5,167.64 | 164,086 | 2,425,444 | 252,970 | ..... | 612,259 |
| Lead | 280,917 | 16,182.91 | 7,269,200 | 1,860,807 | 87,231,209 | ..... | 12,652,656 |
| Zinc | 1,578 | ..... | ..... | ..... | ..... | 479,449 | 27,328 |
| Copper-lead | 1,107 | 34.37 | 18,448 | 123,883 | 132,199 | ..... | 43,153 |

*Mine production of metals from Utah crude ore shipped to smelters in 1922*—Contd.

| Kind of ore. | Ore. | Average content. Gold. | Silver. | Copper. | Lead. | Recoverable zinc. | Total value. |
|---|---|---|---|---|---|---|---|
| | *Short tons.* | *Fine ounces.* | *Fine ounces.* | *Per cent.* | *Per cent.* | *Per cent.* | |
| Dry and siliceous | 176,714 | 0.11 | 31.06 | 0.60 | 1.50 | ..... | $36.49 |
| Copper: | | | | | | | |
| Oxidized | 6,817 | .21 | 14.95 | 5.03 | .92 | ..... | 33.88 |
| Sulphide | 30,852 | .12 | 2.02 | 2.82 | .21 | ..... | 12.35 |
| Lead: | | | | | | | |
| Oxidized | 55,399 | .08 | 20.21 | .24 | 16.55 | ..... | 40.63 |
| Sulphide | 225,518 | .05 | 27.27 | .35 | 15.28 | ..... | 48.12 |
| Zinc: | | | | | | | |
| Oxidized | 1,578 | ..... | ..... | ..... | ..... | 15.19 | 17.32 |
| Copper-lead: | | | | | | | |
| Oxidized | 27 | .11 | 36.96 | 2.78 | 15.97 | ..... | 64.29 |
| Sulphide | 1,080 | .03 | 16.16 | 5.67 | 5.72 | ..... | 38.35 |
| | 497,985 | .08 | 25.98 | .65 | 9.33 | .05 | 39.72 |

## GOLD.

The mine production of gold increased 30 per cent. Ores mined in Salt Lake, Juab, and Piute counties, named in order of output, produced most of the gold.

Gold produced in Utah is largely a by-product of the copper and lead ores and concentrates smelted. The Utah Copper property, at Bingham, was the largest producer of gold in 1922; the Deer Trail property, in Piute County, was second; and the United States, Grand Central, Chief Consolidated, Niagara, Park-Utah, Utah Consolidated, and Mammoth mines followed in order.

## SILVER.

The output of silver increased 41 per cent. Juab County had the largest output, followed by Wasatch, Summit, Utah, and Salt Lake counties. This marked increase was especially noticeable in the Park City and Tintic districts.

Cyanidation of gold and silver ores was reported by only one operator, and no ore was treated by amalgamation in 1922. Leaching mills using a chloridizing-roasting process recover rich silver bullion, from which 1,313,927 ounces of silver was reported in 1922.

Nine properties each produced more than 500,000 ounces of silver in 1922. The Chief Consolidated, in the Tintic district, ranked first, with an output of 3,768,390 ounces, followed by the Park-Utah, in the Park City district; the Tintic Standard, in the Tintic district; the Silver King Coalition, in the Park City district; the Vipont Silver, in Box Elder County; the Ontario and Judge, at Park City; and the Grand Central and Victoria, in the Tintic district.

## COPPER.

The largest quantity of copper in 1922 was produced from ores mined in the Bingham or West Mountain district, Salt Lake County, followed by the Tintic district, in Juab County, and the Park City region, in Summit and Wasatch counties.

The copper concentrates produced at milling plants contained 88,098,018 pounds; lead concentrates, 1,478,946 pounds; dry and

siliceous concentrates, 90,879 pounds; and copper-lead concentrates, 1,350 pounds. Crude ore shipped to smelters contained 6,517,059 pounds of copper, against 5,339,848 pounds in 1921. The crude copper ore smelted contained 2,425,444 pounds, of which 1,740,204 pounds was derived from sulphide ores and 685,240 pounds from oxidized ores. Lead ores smelted produced 1,860,807 pounds of copper, the sulphide ores yielding 1,593,848 pounds and the oxidized ores 266,959 pounds. Copper-lead ores, which were mostly sulphide, contained 123,883 pounds of copper. The dry and siliceous ores, used principally for fluxing at smelting plants, contained 2,106,925 pounds, against 1,168,828 pounds in 1921. The low-grade copper-bearing disseminated ores concentrated contained 88,098,018 pounds of copper, against 23,933,710 pounds in 1921.

The leading producers of copper, named in order of production, were the Utah Copper Co. (reporting 84,777,712 net pounds),[2] the Utah Consolidated, the Montana-Bingham, the Grand Central, and the mines of the United States Smelting, Refining & Mining Co. The Ohio Copper Co., at Lark, did some work in leaching low-grade copper ore in place.

## LEAD.

The output of lead increased 52 per cent, owing largely to the renewal of operations of the Utah Apex mine, at Bingham, and the Silver King Coalition mine, at Park City. The Pittman Act had much to do with stimulating the production of silver-lead ores. Purchase of silver under the act ceased in 1923, and the records for that year may show a reaction in mining activity, due to the much lower price of silver.

The Bingham or West Mountain district produced 38,695,793 pounds, compared with 24,576,646 pounds in 1921. The greatest part of the production at Bingham came from the United States and Utah Apex mines. The Park City region produced 32,257,593 pounds, against 17,691,222 pounds in 1921; the Tintic district produced 47,291,192 pounds, against 36,315,543 pounds; the combined production of the Ophir and Rush Valley districts, Tooele County, increased from 2,173,809 pounds in 1921 to 7,013,845 pounds; and the output in Beaver County increased from 1,271,131 pounds to 2,375,746 pounds.

Ranking first in the output of lead was the Chief Consolidated property, in the Tintic district, followed in order by the property of the United States Mining Co., at Bingham; the Silver King Coalition, in the Park City district; the Utah Apex, at Bingham; the Tintic Standard, in the Tintic district; and the Judge, in the Park City district. Each of these was credited with producing more than 8,000,000 pounds of lead. Those following were the Ophir Hill, Victoria, Eagle & Blue Bell, Niagara, and Ontario mines.

## ZINC.

Considerable zinc oxide was recovered from an accumulation of zinc carbonate ore at the oxide plant of the Utah Zinc Co. operated near Murray. After the stocks of ore were reduced the plant was closed by the company to await a better market for its product.

[2] Utah Copper Co. Seventeenth Ann. Rept., for year ending Dec. 31, 1922.

Most of the zinc reported in 1922 was obtained from an accumulation at the zinc concentrator of the Midvale smelter. The content of accumulated product added to the current production accounted for the suddenly increased output of zinc contained in concentrate.

## MINING INDUSTRY.

The Pittman Act had the effect of greatly stimulating the mining industry and increasing the output of silver and lead. Utah not only produced more silver than any other State but broke its own record of silver production. The increase in the production of silver and the resumption of copper mining on a large scale at Bingham were the outstanding features of 1922. In January all mine employees had wages reduced 50 cents a shift, but in March the old scale was restored. In February the wages at the smelters were reduced 50 cents a shift. A shortage of skilled miners prevailed throughout the year, but the condition was not generally acute. Freight rates on ores from the Tintic district and from points in Nevada and California to the Salt Lake smelters were reduced July 10. The new rates made marketable a considerable output of low-grade ores available in the Tintic district. The rate on iron ore was reduced from $1.50 to $1 a ton. On $50 ore the rate was reduced from $3.10 to $2 a ton, $30 ore was to be carried for $1.50 a ton, and $10 ore for $1 a ton. Toward the last of 1922 the smelters were reported to be operating near their capacity; the Garfield copper smelter was running at 80 per cent of its capacity, and at the Murray lead smelter all furnaces were in operation. In July two lead furnaces were blown in at International, and the copper furnace was operated part of the year. At Midvale three furnaces were operated most of 1922 on lead ores, and the fourth furnace was worked intermittently on matte.

## REVIEW BY COUNTIES.

### GENERAL FEATURES.

*Mine production of gold, silver, copper, lead, and zinc in Utah in 1922.*

| County. | Gold. | | | | | Silver. | |
|---|---|---|---|---|---|---|---|
| | Placers. | | Deep mines. | | Total value. | Fine ounces. | Value. |
| | Fine ounces. | Value. | Fine ounces. | Value. | | | |
| Beaver | | | 535.75 | $11,075 | $11,075 | 114,876 | $114,876 |
| Box Elder | | | 2,976.03 | 61,520 | 61,520 | 1,043,671 | 1,043,671 |
| Garfield | 6.77 | $140 | | | 140 | | |
| Grand | 2.17 | 45 | | | 45 | 402 | 402 |
| Iron | | | 1.98 | 41 | 41 | 10 | 10 |
| Juab | | | 21,060.39 | 435,357 | 435,357 | 6,338,689 | 6,338,689 |
| Piute | | | 18,250.20 | 377,265 | 377,265 | 290,354 | 290,354 |
| Salt Lake | | | 57,728.36 | 1,193,351 | 1,193,351 | 1,678,618 | 1,678,618 |
| Sevier | | | 1.45 | 30 | 30 | 65 | 65 |
| Summit | | | 3,914.21 | 80,914 | 80,914 | 2,276,066 | 2,276,066 |
| Tooele | | | 475.24 | 9,824 | 9,824 | 341,188 | 341,188 |
| Uintah | 21.58 | 446 | | | 446 | 1 | 1 |
| Utah | | | 1,797.37 | 37,155 | 37,155 | 2,217,547 | 2,217,547 |
| Wasatch | | | 4,265.66 | 88,179 | 88,179 | 2,969,128 | 2,969,128 |
| Washington | | | .68 | 14 | 14 | 480 | 480 |
| Wayne | 72.52 | 1,499 | | | 1,499 | 5 | 5 |
| | 103.04 | 2,130 | 111,007.32 | 2,294,725 | 2,296,855 | 17,271,100 | 17,271,100 |

*Mine production of gold, silver, copper, lead, and zinc in Utah in 1922*—Continued.

| County. | Copper. | | Lead. | | Recoverable zinc. | | Total value. |
|---|---|---|---|---|---|---|---|
| | Pounds. | Value. | Pounds. | Value. | Pounds. | Value. | |
| Beaver | 46,770 | $6,314 | 2,375,746 | $130,666 | 6,375 | $363 | $263,294 |
| Box Elder | 28,735 | 3,879 | 210,310 | 11,567 | 411,476 | 23,454 | 1,144,091 |
| Garfield | | | | | | | 140 |
| Grand | 885 | 120 | | | | | 567 |
| Iron | 1,498 | 202 | 2,120 | 117 | | | 370 |
| Juab | 1,811,150 | 244,505 | 36,072,127 | 1,983,967 | 24,022 | 1,369 | 9,003,887 |
| Piute | 49,438 | 6,674 | 1,622,984 | 89,264 | | | 763,557 |
| Salt Lake | 92,520,204 | 12,490,228 | 44,237,444 | 2,433,060 | 4,633,586 | 264,115 | 18,059,372 |
| Sevier | | | | | | | 95 |
| Summit | 797,090 | 107,607 | 22,660,259 | 1,246,314 | | | 3,710,901 |
| Tooele | 776,919 | 104,884 | 7,036,516 | 387,008 | 43,951 | 2,505 | 845,409 |
| Uintah | | | | | | | 447 |
| Utah | 515,396 | 69,579 | 11,517,304 | 633,452 | | | 2,957,733 |
| Wasatch | 645,765 | 87,178 | 9,597,334 | 527,853 | | | 3,672,338 |
| Washington | | | | | | | 494 |
| Wayne | | | | | | | 1,504 |
| | 97,193,850 | 13,121,170 | 135,332,144 | 7,443,268 | 5,119,410 | 291,806 | 40,424,199 |

*Ores sold or treated, number of deep mines producing, and value of ores in Utah in 1921 and 1922.*

| County. | Ore sold or treated, 1922 (short tons). | | Number of deep mines producing. | | Average total value per ton.[a] | | Average value per ton in gold and silver.[a] | |
|---|---|---|---|---|---|---|---|---|
| | Total. | Increase or decrease. | 1921 | 1922 | 1921 | 1922 | 1921 | 1922 |
| Beaver | 11,591 | +4,586 | 11 | 7 | $20.98 | $22.72 | $12.29 | $10.87 |
| Box Elder | 65,366 | +22,147 | 1 | 4 | 17.24 | 17.50 | 17.22 | 16.91 |
| Grand | 10 | +10 | | 1 | | 52.20 | | 40.20 |
| Iron | 5 | +5 | | 2 | | 74.00 | | 10.20 |
| Juab | 246,910 | +43,212 | 30 | 36 | 32.86 | 36.47 | 26.33 | 27.44 |
| Piute | 38,382 | +2,761 | 4 | 4 | 18.61 | 19.89 | 16.48 | 17.39 |
| Salt Lake | 4,763,418 | +3,202,652 | 45 | 43 | 4.65 | 3.79 | 1.45 | .60 |
| Sevier | 7 | +7 | | 1 | | 13.57 | | 13.57 |
| Summit | 171,592 | +97,769 | 8 | 12 | 25.73 | 21.63 | 18.61 | 13.74 |
| Tooele | 57,230 | +39,743 | 19 | 21 | 12.43 | 14.77 | 5.18 | 6.13 |
| Utah | 120,019 | −19,052 | 9 | 11 | 22.54 | 24.64 | 18.83 | 18.79 |
| Wasatch | 85,488 | +28,703 | 5 | 4 | 22.23 | 42.96 | 15.63 | 35.76 |
| Washington | 16 | −25 | 1 | 1 | 13.02 | 30.87 | 13.02 | 30.87 |
| Weber | | −6 | 1 | | 68.00 | | 3.67 | |
| | 5,560,034 | +3,422,512 | 134 | 147 | 10.30 | 7.27 | 6.56 | 3.52 |

[a] Value per ton, placer product excluded.

## BEAVER COUNTY.

*Mine production of gold, silver, copper, lead, and zinc in Beaver County, Utah, 1921–22.*

| Year. | Number of producers. | Ore. | Gold. | Silver. | Copper. | Lead. | Recoverable zinc. | Total value. |
|---|---|---|---|---|---|---|---|---|
| | | *Short tons.* | | *Fine ounces.* | *Pounds.* | *Pounds.* | *Pounds.* | |
| 1921 | 11 | 7,005 | $5,206 | 80,894 | 28,158 | 1,271,131 | | $146,933 |
| 1922 | 7 | 11,591 | 11,075 | 114,876 | 46,770 | 2,375,746 | 6,375 | 263,294 |
| Increase or decrease, 1922 | −4 | +4,586 | +5,869 | +33,982 | +18,612 | +1,104,615 | +6,375 | +116,361 |
| Total, 1860–1922 | | | 867,772 | 22,185,728 | 52,934,874 | 429,262,656 | 36,077,149 | 52,705,859 |

*Beaver Lake district.*—At the property of the Beaver Copper Co. development on the 470-foot level disclosed a large deposit of iron pyrite.

*Granite district.*—A test shipment of lead ore containing a little silver was made from the Lucky Jim claim, 9 miles north of the Minersville reservoir.

*Rocky district.*—From open pits of the Montreal mine the Milford Copper Co. mined iron ore which was shipped to the smelter for flux. The quantity of silver and copper contained in the ore was not large.

*San Francisco district (Frisco, Newhouse).*—Oxidized lead ore from the Horn Silver property was mined largely by lessees and shipped with some concentrates to the smelter. Silver ore was shipped to the Tintic mill at Silver City. The mill on the Quad Metals property was idle, but considerable lead-silver ore was shipped to the smelters during the year.

*Star and North Star districts.*—Four producers in the Star district reported the output of 1,363 tons of ore of shipping grade, containing gold, silver, lead, and a little copper, valued at $23,191, or $17.01 a ton. Part of the output, consisting of silver ore, was shipped to the leaching plant at Silver City, and the remainder was shipped to the smelters. The producers were the Harrington-Hickory, Wild Bill, Lady Bryan, and Humboldt claims.

### BOX ELDER COUNTY.

*Ashbrook district (Vipont).*—The Vipont Silver Mining Co., which ranks fifth among the producers of silver in Utah and employs about 300 men in its mine and mill, eclipsed all former records. A sulphide concentrate containing principally pyrite and a little galena, with about 3 per cent of arsenic, was recovered in the mill and shipped to the smelter near Tooele. The mine is opened by tunnels, one of which is 2,700 feet long and another 4,000 feet. Altogether 16,000 feet of development work was done on the property in 1922. A 250-ton flotation mill was operated the greater part of the year. The product from the mine and mill was hauled by autotrucks and wagons to Oakley, Idaho, 26 miles north, and shipped by the Oregon Short Line Railroad to the smelters near Salt Lake.

*Lucin district.*—Lessees of the Copper Mountain property shipped to the copper and lead smelters ore taken out in doing development work during 1922. Oxidized zinc ore from the Tecoma mine was shipped to the Utah Zinc Co. near Murray. The Tecoma mine is said to have a reserve of oxidized zinc ore estimated at 50,000 tons, which contains about 18 per cent of zinc. From the High Grade claim a small lot of lead ore was shipped. About 100 feet of development work was done on the Mineral Mountain property, which is opened by a tunnel 850 feet long.

*Park Valley district.*—Early in 1922 the Gold Quartz Leasing Co. did development work on the Susannah mine.

### JUAB COUNTY.

*Fish Springs district.*—The output of the Fish Springs district consisted of several lots of oxidized lead ore from the Galena, Carnation, and Vincent properties and a few lots of lead concentrate resulting from the milling of dump ore from the Utah mine.

*Tintic district.*—The review of the Tintic district includes a number of important mines in the eastern part of the district in Utah County.

*Mine production of gold, silver, copper, lead, and zinc in Tintic district, Utah, 1921–22.*

| County. | Year. | Number of producers. | Ore. | Gold. | Silver. | Copper. | Lead. | Recoverable zinc. | Total value. |
|---|---|---|---|---|---|---|---|---|---|
| | | | *Short tons.* | | *Fine ounces.* | *Pounds.* | *Pounds.* | *Pounds.* | |
| Juab | 1921 | 27 | 203,057 | $332,881 | 5,020,368 | 821,315 | 27,102,709 | ..... | $6,678,821 |
| | 1922 | 29 | 246,232 | 435,092 | 6,323,713 | 1,810,804 | 35,878,517 | 24,022 | 8,977,951 |
| Utah | 1921 | 5 | 138,690 | 54,893 | 2,556,834 | 748,737 | 9,212,834 | ..... | 3,122,891 |
| | 1922 | 6 | 119,480 | 30,229 | 2,210,241 | 484,315 | 11,412,675 | ..... | 2,933,550 |
| Total | 1921 | 32 | 341,747 | 387,774 | 7,577,202 | 1,570,052 | 36,315,543 | ..... | 9,801,712 |
| | 1922 | 35 | 365,712 | 465,321 | 8,533,954 | 2,295,119 | 47,291,192 | 24,022 | 11,911,501 |
| Total, 1869–1922 | | | | 35,228,207 | 161,729,051 | 188,181,965 | 932,011,905 | 17,367,010 | 235,310,079 |

Total dividends, 1869–1922, $37,512,491.

The values of the metals for 1922 not shown in this table are as follows: Gold, $465,321, against $387,774 in 1921; silver, $8,533,954, against $7,577,202; copper, $309,841, against $202,537; lead, $2,601,016, against $1,634,199; zinc, $1,369. The ore sold or treated in the district in 1922 averaged $32.57 a ton, compared with $28.68 in 1921.

*Mine production of gold, silver, copper, lead, and zinc in Tintic district, Utah, in 1922, by kinds of ore.*

| Kind of ore. | Number of producers. | Ore. | Gold. | Silver. | Copper. | Lead. | Recoverable zinc. |
|---|---|---|---|---|---|---|---|
| | | *Short tons.* | *Fine ounces.* | *Fine ounces.* | *Pounds.* | *Pounds.* | *Pounds.* |
| Dry and siliceous | 28 | 215,255 | 13,923.52 | 4,035,423 | 1,776,406 | 4,435,832 | ..... |
| Copper | 3 | 3,080 | 1,322.93 | 56,248 | 172,001 | 53,027 | ..... |
| Lead | 21 | 147,334 | 7,263.44 | 4,442,283 | 346,712 | 42,802,333 | ..... |
| Zinc | 1 | 43 | ..... | ..... | ..... | ..... | 24,022 |
| | | 365,712 | 22,509.89 | 8,533,954 | 2,295,119 | 47,291,192 | 24,022 |

The Chief Consolidated Co.[3] purchased three additional mines, the stock control of a fourth, and the holdings of the outstanding interest of the Grand Central Mining Co. The additional territory now controlled or owned was formerly the property of the Gemini, Ridge & Valley, Eureka Mines, Eureka Hill, and Plutus mining companies. Three of these companies have produced for many years and have paid dividends aggregating more than $6,250,000.

Mining is conducted at the Chief mine 250 feet below the permanent water level, and the company has an effective system of caring for the continually increasing flow of water as increased depth is reached. Ore was found extending from the Grand Central property into the Plutus ground. Development of the Apex Standard mine was con-

[3] Chief Consolidated Mining Co. Fourteenth Ann. Rept., for year ending Dec. 31, 1922.

tinued by the Chief Consolidated, but no important discoveries were reported. During 1922 lime rock suitable for use at sugar factories was discovered in Chief territory, from which 13,000 tons was quarried and found satisfactory.

The Chief Consolidated Co. was again first in the output of silver and was the largest producer of lead in the State. The combined production of all the properties operated was greater than that of any previous year in the history of the company. The annual report shows 133,790 dry tons of ore shipped, which yielded $3,529,682.71 in net smelter returns, and after paying smelting, transportation, and sampling charges $554,417.83 remained. Dividends amounted to $265,302 in 1922, which makes the total paid to stockholders since February, 1913, $2,402,846.77.

*Ore and metals produced by Chief Consolidated Co. in 1921 and 1922.*

| Year. | Ore. | Gold. | Silver. | Lead. | Copper. | Zinc. |
|---|---|---|---|---|---|---|
| | *Dry tons.* | *Ounces.* | *Ounces.* | *Pounds.* | *Pounds.* | *Pounds.* |
| 1921 | 93,267 | 4,353 | 3,262,241 | 12,496,433 | 11,563 | ..... |
| 1922 | 133,790 | 11,931 | 4,437,033 | 19,779,418 | 957,825 | ..... |
| 1909–1922[a] | 763,034 | 70,812 | 22,691,182 | 107,816,681 | 1,355,585 | 2,401,279 |

[a] The production of the Chief Consolidated mine by years is given in Mineral Resources, 1918, pt. 1, p. 388.

Of the 133,790 dry tons of ore produced, 64,630 tons was silver-lead ore and 42,864 tons dry and siliceous ore from the Chief mine. The Grand Central mine produced 4,732 tons of silver-lead ore and 19,192 tons of dry and siliceous ore, and the Gemini mine produced 2,372 tons of silver-lead ore. The ore from the Chief mine averaged 0.0414 ounce of gold and 35.05 ounces of silver to the ton, 14.02 per cent of lead in lead ores, and 1.28 per cent of copper in copper ores, or a total value of $45.18 a ton. After deducting charges for smelting, freight, and sampling, the ore was valued at $27.31 a ton. The ore from the Grand Central mine averaged 0.277 ounce of gold and 23.22 ounces of silver to the ton, 11.92 per cent of lead in lead ores, and 3.52 per cent of copper in copper ores and was valued at $36.57 a ton. After charges for smelting, freight, and sampling amounting to $15.39 were deducted, the net value was $21.18 a ton. The Gemini ore averaged 28.20 ounces of silver to the ton and 11.12 per cent of lead and was valued at $43.52 a ton. A net value of $23.97 a ton remained after smelting, freight, and sampling charges were deducted. Some of the ore mined was treated by the Tintic Milling Co. at Silver City by the chloridizing-roasting process. The treatment of siliceous ore in roasting furnaces of small capacity at the Chief mine is in the experimental stage. Development in the Chief mine amounted to 11,000 feet of work and in the newly acquired property to 12,200 feet. Ore was produced and development work done in the Chief mine from the 700-foot level to the 2,050-foot level, and in the second ore zone on all levels from the 1,200 to the 2,100 level.

The Centennial-Eureka mine[4] produced 5,408 tons of gold and silver ore of medium grade, and its neighbor, the Bullion Beck & Champion mine, produced 3,664 tons of similar ore. A little mining

[4] United States Smelting, Refining & Mining Co. Seventeenth Ann. Rept., for year ending Dec. 31, 1922.

was done by the company, but most of the ore from both these properties was mined by lessees.

From the Eagle & Blue Bell mine [5] 24,745 dry tons of ore was shipped in 1922, compared with 26,554 tons in 1921. Of the output in 1922, 7,799 tons was mixed carbonate and sulphide lead ore and 16,946 tons was dry and siliceous ore. The lead ore contained 501.93 ounces of gold, 283,601 ounces of silver, and 3,876,588 pounds of lead. The dry ore contained 661.56 ounces of gold and 106,889 ounces of silver. After charges for these two classes of ore for freight, smelting, and sampling were deducted, the net smelter returns amounted to $293,737.97. Dividends distributed in 1922 amounted to $64,306.50, making a total of $1,671,969.30 paid to date. A new ore body has been developed in the north end of the property above the 2,000-foot level. It was found in a favorable formation and in an area but little explored.

A new producer, the American Star mine, was added to the list in the Tintic district on August 18, and the output was 1,064 dry tons of dry and siliceous ore, containing 65.06 ounces of gold, 20,981 ounces of silver, and 11,827 pounds of copper. The American Star mine lies east of the Eagle & Blue Bell mine, through which it is operated. A drift was started from the 1,875-foot level, extending 750 feet north of the Centennial fault. In June the drift was completed to a point corresponding with the 1,650-foot level, where ore was discovered.

The Victoria mine [6] produced 25,242 dry tons of ore in 1922, compared with 26,562 tons in 1921. Of this output, 19,840 tons was lead ore containing 766.22 ounces of gold, 398,040 ounces of silver, 4,483,992 pounds of lead, and 5,248 pounds of copper. The dry and siliceous ore amounted to 5,401 tons, containing 420.93 ounces of gold, 82,882 ounces of silver, and 11,727 pounds of copper. A steady output of lead-silver ore was mined from the stopes on the 1,450-foot level and also from the 1,350 level and above.

The Iron Blossom mine [7] produced in 1922 ore that sold for $336,033.99. Part of the output was lead ore of smelting grade, but most of it was silver ore treated by the Tintic Milling Co. at Silver City. The company did 4,054 feet of development work and paid $75,000 in dividends. Work was confined to the 600-foot level and to levels above. On the 500-foot level a vein 8 feet wide was opened 120 feet east of the other vein systems. The ore was of low grade, however, and only a small quantity of shipping ore was mined and shipped.

At the Colorado mine [8] work was continued on the vein west of the old ore channel paralleling the old stopes. Though no commercial ore was opened, the work was of geologic interest in correlating the limestone formations. Lessees opened up new ore, the total sales of which amounted to $106,905.

The output of the Dragon mine [9] consisted of iron ore for flux, which sold for $14,179, and some siliceous ore valued at $14,072, most of which was sold to the mill at Silver City. Considerable talc suitable for use as an oil filterer was developed in the mine, and several car lots were sold for $1,615. The Tintic Milling Co. abandoned its lease on the Dragon mine, which was idle until July. Subsequently sev-

[5] Eagle & Blue Bell Mining Co. Ann. Rept. for year ending Dec. 31, 1922.
[6] Bingham Mines Co. Fourteenth Ann. Rept., for year ending Dec. 31, 1922.
[7] Iron Blossom Consolidated Mining Co. Ann. Rept. for year ending Dec. 31, 1922.
[8] Colorado Consolidated Mines Co. Ann. Rept. for year ending Dec. 31, 1922.
[9] Dragon Consolidated Mining Co. Ann Rept. for year ending Dec. 31, 1922.

eral lessees opened up considerable ore of smelting and milling grades. In September shipments of iron ore began at the rate of 100 tons a day.

According to an annual statement of the Tintic Standard Mining Co., ore containing gold, silver, copper, and lead valued at $2,731,480.36 was produced in 1922. Of this amount $976,186.77 was the value of the milling ore treated at the company's plant at Warm Springs. The net operating profit on the total ore, after mining, smelting, and transportation charges were deducted, was $904,472.46. Of this amount the milling ore returned a profit of $251,663.43. The net income after deducting all expenses, including taxes, amounted to $448,462.56. Dividends paid to stockholders amounted to $234,940 in 1922, making a total of $1,770,855 to date.

According to a statement of income issued by the Tintic Milling Co., sales of its product amounted to $412,881, but a loss of $71,580.72 was shown for the year. The mill treated custom ore but was not operated continuously. Some experimental work was done by the company in precipitating metals from solution on sponge iron, which is found to save the lead successfully. The ores treated at the plant by chloridizing-roasting came from the Alaska, Empire, Bullion Beck, Tintic Drain Tunnel, Eureka Hill, Grand Central, Iron Blossom, Colorado, Sioux, Joe Bowers, Little May, Dragon, Martha Washington, Chief Consolidated, Republic, Showers, Swansea, United Sunbeam, Lady Aspinwall, and Sunday mines, in the Tintic district. Some ore from the Horn Silver and Harrington-Hickory mines, in Beaver County, was also treated at Silver City. The total of all the ore treated by the chloridizing-roasting process, including ore treated by the same process at the Tintic Standard mill, amounted to 116,509 tons, from which was saved 458.42 ounces of gold, 1,310,598 ounces of silver, 162,305 pounds of copper, and 1,195,000 pounds of lead.

*West Tintic district.*—Lead ore containing a little silver was shipped to the smelter from the Imperial lead mine, for which a concentration mill is planned. A small shipment of lead ore was also made from the old Scotia property.

### PIUTE COUNTY.

*Mount Baldy district.*—The Deer Trail mine continued to be a large producer of gold recovered from ore treated by cyanidation and concentration. Precipitates containing gold and silver from cyanide operations were shipped to Omaha, Nebr., and lead concentrates were smelted at Midvale. A fault fissure or shattered vertical zone in quartzite, said to be 100 feet wide, was recently opened in the Deer Trail mine, and with the exception of some boulders of limestone all the ore filling the fissure was of milling grade.

*Ohio district.*—The Bully Boy mine was operated part of the year, and a little lead concentrate was shipped to the smelter.

### SALT LAKE COUNTY.

*Big and Little Cottonwood districts.*—The largest producers of lead-silver ore in the Big Cottonwood district were the Cardiff mine and the Alta Tunnel Co., leasing the Prince of Wales property. Lead ore was also shipped from the Prince of Wales mine by the Pyramid Leasing Co. The remaining output of the district came from the

Howell, Cottonwood King, Richmond Tressa, and Woodlawn properties. The total output of 6,953 tons of ore reported by seven producers in the Big Cottonwood district contained $584 in gold, 102,088 ounces of silver, 63,230 pounds of copper, and 3,152,957 pounds of lead, valued in all at $284,621, or $40.93 a ton.

In the Little Cottonwood district seven producers reported 10,506 tons of ore shipped to the smelter, containing $5,185 in gold, 192,389 ounces of silver, 692,765 pounds of copper, and 2,355,176 pounds of lead, valued in all at $420,632, or $40.04 a ton.

*Mine production of gold, silver, copper, lead, and zinc in Big Cottonwood and Little Cottonwood mining districts, Utah, 1921–22.*

| Year. | Number of producers. | Ore. | Gold. | Silver. | Copper. | Lead. | Recoverable zinc. | Total value. |
|---|---|---|---|---|---|---|---|---|
| | | *Short tons.* | | *Fine ounces.* | *Pounds.* | *Pounds.* | *Pounds.* | |
| 1921 | 16 | 11,303 | $5,001 | 310,708 | 296,296 | 4,459,201 | ..... | $554,595 |
| 1922 | 14 | 17,459 | 5,769 | 294,477 | 755,995 | 5,508,133 | ..... | 705,253 |
| Increase or decrease, 1922 | −2 | +3,156 | +768 | −16,231 | +459,699 | +1,048,932 | ..... | +150,658 |
| Total, 1867–1922 | ..... | 536,591 | 538,118 | 14,962,955 | 14,106,229 | 206,948,019 | 322,055 | 30,124,840 |

The largest part of the output of the Little Cottonwood district, or more than 4,000 tons, came from the drain tunnel of the Wasatch Mines Co., which shipped copper-lead sulphide ore and some oxidized copper ore containing silver and a little gold. A typical analysis of the oxidized copper ore mined in 1922 showed 60 cents in gold and 20 ounces of silver to the ton, 4 per cent of lead, 9 per cent of copper, 1.5 per cent of zinc, 20 per cent of iron, 3 per cent of lime, 3 per cent of arsenic, and 30 per cent of insoluble matter. The second largest shipper was the Columbus Rexall mine, which produced more than 3,500 tons of oxidized lead ore and copper ore. The company operating this property has paid dividends amounting to $49,827, of which $35,171 was paid in 1922. The Michigan-Utah Co. did about 2,000 feet of development work and shipped considerable oxidized lead ore from a deposit recently developed. There were no important changes at the property of the South Hecla Mines Co., but operations were continued on a small scale, and a little oxidized lead ore was shipped to the smelter.

*Smelter district.*—Old slag sorted from the smelter dumps and ore from car and track cleanings near the smelters amounted to nearly 150 tons. The old tailing dumps near the Midvale smelter were not worked. The smelter at Murray and the concentrator and smelter at Midvale were in operation during 1922. The annual report [10] of the company operating the Midvale plant gives the following information:

> The concentrator milled 125,218 tons of lead-zinc ore, a decrease of 13,553 tons from the previous year, due to decreased shipments from the Bingham mines during the labor shortage. The mills also handled a small tonnage of low-grade copper ore. The lead smelter treated 190,988 tons of marginal ore, a small increase over the tonnage

[10] United States Smelting, Refining & Mining Co. Seventeenth Ann. Rept., for year ending Dec. 31, 1922.

for the previous year. Lead-bullion output was 32,175 tons, an increase of 4,565 tons over 1921. An increasing lead price resulted in increased receipts of custom ore toward the end of the year, allowing a scale of operations in December considerably above the average. Improved market conditions also made possible an increased production and sale of arsenic, sodium arsenite, and cadmium.

*Bingham or West Mountain district.*—The average value of the ore produced in the Bingham district in 1922 was $3.66 a ton, against $4.32 in 1921. The shipments of ore to the smelters amounted to 104,840 tons, against 71,118 tons in 1921; the output of concentrating ore was 4,639,779 tons, against 1,367,490 tons; and the quantity of concentrates produced was 265,719 tons against 114,950 tons. Ore of smelting grade amounting to 104,840 tons consisted of low-grade copper and lead sulphides and contained 7,244.52 ounces of gold, 505,536 ounces of silver, 2,487,854 pounds of copper, and 15,232,686 pounds of lead, valued in all at $1,828,951, or $17.45 a ton. Milling ores, of which there were 4,639,779 short tons, yielded 265,719 tons of copper, lead, and zinc concentrates that contained 50,183.85 ounces of gold, 872,844 ounces of silver, 88,701,643 pounds of copper, 23,463,107 pounds of lead, and 4,633,586 pounds of recoverable zinc, valued in all at $15,439,543, or $58.10 a ton. The total output of the district includes the metallic content of copper precipitates recovered from leaching ore in place, mine waters, and a little slag from an old smelter dump.

*Mine production of gold, silver, copper, lead, and zinc in Bingham or West Mountain district, Utah, 1921–22.*

| Year. | Number of producers. | Ore. | Gold. | Silver. | Copper. | Lead. | Recoverable zinc. | Total value. |
|---|---|---|---|---|---|---|---|---|
| | | *Short tons.* | | *Fine ounces.* | *Pounds.* | *Pounds.* | *Pounds.* | |
| 1921 | 23 | 1,538,309 | [a]$954,525 | [a]973,984 | 28,011,004 | 24,576,646 | 69,390 | $6,651,346 |
| 1922 | 26 | 4,745,810 | 1,187,355 | 1,381,299 | 91,761,737 | 38,695,793 | 4,633,586 | 17,348,873 |
| Increase, 1922 | 3 | 3,207,501 | 232,830 | 407,315 | 63,750,733 | 14,119,147 | 4,564,196 | 10,697,527 |
| Total, 1865–1922 | ..... | ..... | [a]37,960,839 | [a]56,405,969 | 2,216,971,051 | 1,308,237,711 | 55,174,961 | 562,043,651 |

[a] Includes small placer production.

Total dividends, 1865–1922, $129,629,568.

*Ore and metals produced in Bingham district, Utah, in 1922.*

| Source of production. | Number of producers. | Ore. | Gold. | Silver. | Copper. | Lead. | Recoverable zinc. |
|---|---|---|---|---|---|---|---|
| | | *Short tons.* | *Fine ounces.* | *Fine ounces.* | *Pounds.* | *Pounds.* | *Pounds.* |
| Dry and siliceous ore | 4 | 26,215 | 1,233.87 | 97,088 | 367,619 | 542,271 | ..... |
| Copper ore | 15 | 4,502,419 | 34,681.78 | 370,675 | 90,380,258 | 127,125 | ..... |
| Lead ore | 17 | 91,223 | 3,157.40 | 431,420 | 613,725 | 19,206,180 | ..... |
| Lead-zinc ore | 3 | 125,953 | 18,365.27 | 482,116 | 400,135 | 18,820,217 | 4,633,586 |
| | ..... | 4,745,810 | 57,438.32 | 1,381,299 | 91,761,737 | 38,695,793 | 4,633,586 |

The Utah Copper Co.[11] shipped from its mines to the milling plants at Garfield 4,644,361 wet tons of ore, compared with 1,220,700 tons of concentrating copper ore treated in 1921. After a year's idleness

[11] Utah Copper Co. Eighteenth Ann. Rept., for year ending Dec. 31, 1922.

operations were resumed April 4 at the Arthur plant, the better equipped and more efficient of the two concentrating mills. The Magna mill was improved, and one remodeled section was placed in operation November 10. The Arthur and Magna mills treated a daily average of 16,139 tons of ore, or a total of 4,364,251 tons, from which was recovered concentrate containing 87,844,058 pounds of copper, or an average of 23.49 per cent of copper, compared with 23,730,798 pounds and 21.32 per cent concentrate for the short operating period of the year 1921. There was an additional production of 189,295 pounds of copper contained in precipitates from mine water, shipped direct to the smelter.

The average grade of the ore was 1.26 per cent of copper, compared with 1.16 per cent in 1921, and the average recovery was 80 per cent, corresponding to 20.13 pounds of copper per ton of ore treated, compared with 83.87 per cent or 19.44 pounds of copper per ton of ore treated in 1921. The average milling cost was 84 cents a ton, and the cost of mining was 38.33 cents a ton, of which 12.5 cents represented charges for stripping. The actual direct cost of mining all ore was 25.83 cents a ton.

The average cost per pound of net copper produced from concentrates only was 9.25 cents, and the average cost of total net production was 9.27 cents, exclusive of charges for depreciation of plant and equipment. This cost includes all general charges except depreciation. No credits are applied in the above-stated costs for income derived from gold and silver or miscellaneous sources. The net value of the gold and silver recovered and the proportion of miscellaneous income earned are equivalent to 1.45 cents a pound. The net cost of the production in 1922, after applying this credit, becomes 7.82 cents a pound.

Altogether the Utah Copper Co. sold 84,777,712 pounds of copper at 13.584 cents a pound, 28,283.768 ounces of gold at $20 an ounce, and 257,145 ounces of silver at 99.50 cents an ounce, a total return of $12,337,665.05. Dividends from capital distributions amounted to $3,248,980 in 1922, which makes the total disbursements to stockholders $118,819,867.50.

The United States Smelting, Refining & Mining Co. in its annual report [12] refers to its Utah property as follows:

> The Bingham mines, including the Niagara Mining Co., were operated throughout the year, producing 129,687 tons of complex lead-zinc ore, 5,675 tons of copper ore, 2,203 tons of copper-iron concentrates, and 88 tons of copper cement. During the summer both production and development were considerably interfered with by an acute labor shortage. By the end of the year this condition was practically overcome, when development as well as production increased to a normal basis. Development on the lowest levels of the property has been gratifying in width and values of the ore bodies and is reassuring for the persistency of these ore bodies at the greater depth of the Butterfield tunnel now being driven into your ground.

Development of the Lark vein of the Dalton & Lark mines [13] was continued below the Mascotte tunnel level. A raise from the 1,000-foot level to the Sampson workings provides for the development of the unexplored area on the Lead mine vein between the Mascotte tunnel and the old surface workings above. A crosscut driven from the 1,100-foot drift of the Yosemite mine permits the development

[12] United States Smelting, Refining & Mining Co. Seventeenth Ann. Rept., for year ending Dec. 31, 1922.
[13] Bingham Mines Co. Fourteenth Ann. Rept., for year ending Dec. 31, 1922.

of the Revere and Gladstone mines at depth. The company's output, exclusive of ore mined by lessees, was as follows:

*Mine production of gold, silver, lead, and copper by Dalton & Lark mines, Bingham district, Utah, 1922.*

| Kind of ore. | Ore. | Gold. | Silver. | Lead. | Copper. | Gross value. | Smelter returns. |
|---|---|---|---|---|---|---|---|
| | *Dry tons.* | *Ounces.* | *Ounces.* | *Pounds.* | *Pounds.* | | |
| Lead ore | 914.03 | 18.28 | 5,371.70 | 369,562 | 13,037 | $24,727.13 | $17,980.59 |
| Copper ore | 19,717.62 | 910.39 | 58,511.89 | ..... | 227,849 | 78,413.01 | 69,490.78 |
| | 20,631.65 | 928.67 | 63,883.59 | 369,562 | 240,886 | 103,140.14 | 87,471.37 |
| Company and lease ore produced, 1909–1922 | ..... | 34,110 | 2,836,295 | 42,081,199 | 12,737,692 | ..... | ..... |

Operations at the Yosemite mine [14] were discontinued in July, after exploration of the mineralized fissure on the 1,100-foot level failed to disclose any great quantity of ore. Seven carloads of lead-silver ore were shipped, amounting to 323.5 dry tons, containing 12.76 ounces of gold, 2,062.9 ounces of silver, and 83,304 pounds of lead, valued in all at $4,826.76, the smelter returns amounting to $1,807.22.

The Mayflower vein of the Montana-Bingham property [15] produced from mining and development operations 19,644 dry tons of ore, containing 1,027.31 ounces of gold, 33,014 ounces of silver, 1,088,711 pounds of copper, and 44,932 pounds of lead, valued in all at $141,588. After deducting freight, smelting, sampling, and assay charges, the smelter returns amounted to $105,422. Nearly all the output (1,016 tons) was low-grade copper ore, averaging 2.79 per cent of copper, as compared with 3.43 per cent in 1921. Two carloads of lead ore, averaging 25.46 per cent of lead, were mined from the workings below the tunnel level west of the shaft. Two carloads of iron sulphide were shipped to the Tintic mill at Silver City for experimental purposes. In addition, lessees shipped 13.5 tons of copper ore from the old Fortuna workings.

From the Highland Boy mine [16] 109,320 dry tons of ore, averaging 2.03 per cent of copper, 0.047 ounce of gold, and 0.375 ounce of silver to the ton, was mined and shipped to the mill at International. Of this ore 107,460 tons was milled and yielded 15,826 tons of concentrates averaging 11.378 per cent of copper and 0.184 ounce of gold and 1.411 ounces of silver to the ton. Crude ore of smelting grade amounting to 5,130 tons averaged 2.16 per cent of copper and 0.05 ounce of gold and 0.4 ounce of silver to the ton. The milling plant, equipped for flotation concentration with Callow cells, began operations in June. Recoveries were low the first two months, owing to the heating of the ore, which carries a high percentage of sulphur, in a highly efficient grinding circuit. This trouble was overcome by lowering the density of the pulp in the ball mills. The recoveries in December were 93.49 per cent of the copper, 60.85 per cent of the gold, and 57.77 per cent of the silver. Ore of milling grade measured in the mine is estimated by the company as 715,700 tons, averaging 1.89 per cent of copper and 0.046 ounce of gold and 0.468 ounce of silver to the ton.

[14] Bingham Mines Co. Fourteenth Ann. Rept., for year ending Dec. 31, 1922.
[15] Montana-Bingham Consolidated Mining Co. Ann. Rept. for year ending Dec. 31, 1922.
[16] Utah Consolidated Mining Co. Ann. Rept. for year ending Dec. 31, 1922.

Operations were resumed at the Utah Apex mine [17] toward the end of April, after a shutdown of 15 months. Ore production, beginning with 200 tons a day, was doubled before the end of August. The shaft by which the property is opened has reached a depth of 2,000 feet. Reserves of lead ore of shipping grade containing 12 to 14 per cent of lead amount to over 100,000 tons, and reserves of milling ore are estimated at 80,000 tons.

In the course of development work the Utah Metal & Tunnel Co.[18] mined 1,657 dry tons of ore and shipped some concentrate. The output contained 45,125 pounds of copper, 355,528 pounds of lead, 132 ounces of gold, and 20,582 ounces of silver, or a total value of $42,447.39. The water from the springs on the Middle Canyon side of the mountain supplied to the Utah Copper Co. for raising steam has been an additional source of income to the company for the last eight years.

The most important new development in the Bingham district was the leaching of ore in place in the caved area of the property of the Ohio Copper Co. The water is distributed from the surface and percolates through the shattered ore body to the Mascotte tunnel level, 1,100 feet below, where it is caught in launders and flows to tanks filled with scrap iron. The copper precipitate, about 90 per cent pure, is washed, dried, and shipped to the smelter. The work in 1922 was entirely experimental, and the company, having met with considerable success in producing copper at slightly more than 7 cents a pound, expects to lower the cost by doubling the capacity of the pumping equipment, which at present handles 575 gallons of water a minute.

Other producers were the Congor, Queen (Lavagnino), New England, Bingham Coalition, Bingham Galena, Spring & Summit, Utah Bingham, Ute Copper, and small producers of copper precipitates recovered from mine waters and old tailings.

### SEVIER COUNTY.

*Henry district.*—Silver ore containing a little gold was shipped to the smelter from the Royal Purple mine. The shipment served as a preliminary test on the ore before the erection of a milling plant was begun at Belknap siding, on the Denver & Rio Grande Western Railroad.

### SUMMIT AND WASATCH COUNTIES.

The Uinta district, in Summit County, and the Blue Ledge and Snake Creek districts, in Wasatch County, represent the producing area of the Park City region in 1922.

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[17] Utah Apex Mining Co. Ann. Rept. for year ending Aug. 31, 1922.
[18] Utah Metal & Tunnel Co. Seventh Ann. Rept., for year ending Dec. 31, 1922.

*Mine production of gold, silver, copper, lead, and zinc in Park City mining region, Utah, 1921–22.*

| Year. | Number of producers. | Ore. | Gold. | Silver. | Copper. | Lead. | Recoverable zinc. | Total value. |
|---|---|---|---|---|---|---|---|---|
| | | *Short tons.* | | *Fine ounces.* | *Pounds.* | *Pounds.* | *Pounds.* | |
| 1921 | 13 | 130,608 | $74,002 | 2,187,236 | 805,525 | 17,691,222 | ..... | $3,161,256 |
| 1922 | 16 | 257,080 | 169,093 | 5,245,194 | 1,442,855 | 32,257,593 | ..... | 7,383,239 |
| Increase, 1922 | 3 | 126,472 | 95,091 | 3,057,958 | 637,330 | 14,566,371 | ..... | 4,221,983 |
| Total, 1870–1922 | ..... | ..... | 4,846,136 | 149,922,885 | 36,110,215 | 1,373,757,141 | 74,344,120 | 194,438,806 |

Total dividends, 1870–1922, $46,094,922.

*Mine production of gold, silver, copper, and lead in Park City region, Utah, in 1922, by kinds of ore.*

| Kind of ore. | Number of producers. | Ore. | Gold. | Silver. | Copper. | Lead. |
|---|---|---|---|---|---|---|
| | | *Short tons.* | *Fine ounces.* | *Fine ounces.* | *Pounds.* | *Pounds.* |
| Dry and siliceous | 2 | 74,315 | 4,502.23 | 2,749,094 | 446,934 | 2,033,872 |
| Lead | 15 | 182,765 | 3,677.63 | 2,496,100 | 995,921 | 29,323,721 |
| | ..... | 257,080 | 8,179.86 | 5,245,194 | 1,442,855 | 32,257,593 |

The Silver King Coalition mine [19] produced 74,617 tons of ore, of which 18,966 tons was mixed lead carbonate and sulphide ore, 5,543 tons low-grade iron ore, 49,593 tons milling ore, and 515 tons lessees' ore. The milling ore yielded 7,447 tons of lead concentrate and 5,123 tons of iron concentrate. The average contents of all products mentioned above are given in the following table:

*Gold, silver, copper, and lead produced by Silver King Coalition mine, Utah, 1922.*

| Kind of material. | Gold. | | Silver. | | Lead. | | Copper. | | Net smelter returns. |
|---|---|---|---|---|---|---|---|---|---|
| | Per ton. | Total. | Per ton. | Total. | Percentage. | Total. | Percentage. | Total. | |
| | *Ounce.* | *Ounces.* | *Ounces.* | *Ounces.* | | *Pounds.* | | *Pounds.* | |
| First-class ore | 0.061 | 1,160.77 | 41.41 | 785,391 | 28.56 | 10,840,570 | 0.85 | 320,671 | $1,042,797 |
| Lead concentrates | .048 | 358.82 | 21.54 | 160,385 | 26.13 | 3,892,586 | .26 | 39,489 | 255,311 |
| Iron concentrates | .033 | 168.07 | 11.55 | 59,155 | 7.96 | 815,672 | .04 | 27,962 | 74,806 |
| Crude iron ore | .053 | 296.65 | 7.49 | 41,510 | 5.13 | 568,752 | .27 | 29,885 | 42,364 |
| Lessees' ore | .112 | 57.65 | 43.35 | 22,312 | 37.30 | 383,942 | .53 | 5,451 | 10,123 |
| | ..... | 2,041.96 | ..... | 1,068,753 | ..... | 16,501,522 | ..... | 423,458 | 1,425,401 |

The new concentration mill at the Silver King Coalition mine started operations March 1 with an improved saving of the metallic contents over that of the old plant, which was destroyed by fire. The mining, haulage, and hoisting cost of 74,102 tons of ore averaged $4.53 a ton. Development cost, the same items included, amounted to $13.34 a foot, and milling cost $1.19 a ton of ore treated. Dividends were paid to stockholders amounting to $364,830.

[19] Silver King Coalition Mines Co. Ann. Rept. for year ending Dec. 31, 1922.

No production of ore was reported by the Silver King Consolidated property.[20] The Spiro adit, which opens this property, is 15,015 feet (nearly 3 miles) long. The adit is 8 by 8 feet in the clear, with a 3 by 4 foot water ditch at one side below the track level. The ditch at the present time is carrying nearly 5,000 gallons of water a minute. The terminus of the tunnel is directly under the workings of the California-Comstock mine. The most encouraging prospecting has been done in the Iron Drift workings, so called because they head from the main tunnel into a large body of iron carrying quartz, zinc sulphides, and sporadic lenses of high-grade ore. In the old King Consolidated property a small working force was engaged following stringers of ore that lead out from the old stopes in the hope that the work would disclose new ore bodies.

From the Park-Utah mine[21] 42,807 dry tons of ore was shipped, which sold for $1,503,706, or $35 a ton. This ore contained 3,383.63 ounces of gold, 2,153,534 ounces of silver, 634,021 pounds of lead, and 21,403 pounds of copper. Dividends paid to stockholders amounted to $497,962.50, making a total of $546,036.75 since production began. A railroad surveyed to the portal of the Ontario No. 2 drain tunnel is expected to be in operation by the end of 1923. When completed this arrangement will reduce the company's ore haul 5½ miles and eliminate 900 feet of hoisting. In 1922 the ore was moved to the Daly West shaft, hoisted 900 feet, and then trammed 2½ miles to the loading bins at the portal of the Ontario No. 1 tunnel. The output is reported to come from the 1,600-foot level.

First-class silver-lead ore from the Keystone property[22] was shipped to the smelter. Toward the end of December a new 100-ton concentrating plant constructed near the mouth of the Hanauer adit was completed. The ore and concentrate shipments during the first quarter of 1923 averaged 33 per cent of lead and 12.5 ounces of silver a ton.

The properties of the Daly West, Judge Mining & Smelting, and West Ontario companies were merged February 10 into the Park City Mining & Smelting Co. The combined holdings cover territory 1½ miles southwest of Park City and extend southwestward for about 3½ miles. The area is in Summit, Wasatch, and Salt Lake counties and consists of 2,400 acres of patented ground, exclusive of the Snake Creek tunnel site of 160 acres. The new company[23] sold 22,657 dry tons of first-class lead ore including 6,238 tons mined by lessees and 7,879 tons of silver-lead concentrate reduced from 33,040 tons of mill ore. The average of the ore directly shipped was 0.032 ounce of gold and 37.14 ounces of silver to the ton, 15.88 per cent of lead, and 1.37 per cent of copper, and it sold for $38.72 a ton. The concentrate averaged 0.058 ounce of gold and 33.51 ounces of silver to the ton, 28.11 per cent of lead, and 1.13 per cent of copper and sold for $43.06 a ton. Dividends paid to stockholders amounted to $87,600.

Ore produced from the Ontario mine[24] in 1922 sold for $293,621.19. The development work on the 1,100, 1,200, 1,300, and 1,500 foot levels has all been done east of the Ontario north-south fault, in ground

[20] Silver King Consolidated Mining Co. Ann. Rept. for year ending Dec. 31, 1922.
[21] Park-Utah Mining Co. Financial statement for year ending Dec. 31, 1922.
[22] Keystone Mining Co. Report for first quarter, Apr. 1, 1923.
[23] Park City Mining & Smelting Co. Annual statement for year ending Dec. 31, 1922.
[24] Ontario Silver Mining Co. Ann. Rept. for year ending Dec. 31, 1922.

never before prospected. Later, as this report was being written, ore of good grade and of considerable extent was opened on the 600-foot level east of this fault.

Other producers were the American Flag, Kennally group, Naildriver, and operators of tailings plants.

## TOOELE COUNTY.

*Mine production of gold, silver, copper, lead, and zinc in Tooele County, Utah, 1921–22.*

| Year. | Number of producers. | Ore. | Gold. | Silver. | Copper. | Lead. | Recoverable zinc. | Total value. |
|---|---|---|---|---|---|---|---|---|
| | | *Short tons.* | | *Fine ounces.* | *Pounds.* | *Pounds.* | *Pounds.* | |
| 1921 | 19 | 17,487 | $8,272 | 82,251 | 97,354 | 2,538,512 | ..... | $217,315 |
| 1922 | 21 | 57,230 | 9,824 | 341,188 | 776,919 | 7,036,516 | 43,951 | 845,409 |
| Increase, 1922 | 2 | 39,743 | 1,552 | 258,937 | 679,565 | 4,498,004 | 43,951 | 628,094 |

*Blue Bell district.*—The Blue Bell Mining Co. sold 15 tons of zinc ore to the Utah Zinc Co.

*Clifton district (Gold Hill).*—Three producers in the Clifton district reported the output of 211 tons of ore, containing $5,759 in gold, 2,974 ounces of silver, 4,521 pounds of copper, and 16,524 pounds of lead, valued in all at $10,252, or $48.59 a ton. From the Mineral Hill group, 6 miles north of Gold Hill, some oxidized lead-silver ore was shipped to the smelter. The ore contained an average of 60 cents in gold and 20 ounces of silver to the ton, 8 per cent of lead, and 30 per cent of iron. At the Rube prospect a little gold ore carrying silver and lead was mined from shallow workings. No development work of consequence was done at the property of the Western Utah Copper Co. pending the completion of the calcium arsenate plant of the Salt Lake Insecticide Co. near Salt Lake City.

*Columbia district.*—At the Sharp mine a new ore deposit was reported, the development of which resulted in the shipment of a little oxidized lead ore to the smelter.

*Ophir district.*—Nine producers in the Ophir district reported the output of 55,218 tons of ore, containing $2,596 in gold, 320,470 ounces of silver, 767,426 pounds of copper, 5,841,343 pounds of lead, and 17,684 pounds of recoverable zinc, valued in all at $748,950, or $13.56 a ton. Of this output the shipping ore amounted to 590 tons and the concentrating ore to 54,628 tons, which yielded 21,955 tons of lead concentrate. Considerable development work was done at the Ophir Hill mine, which was operated from April 1 to the end of 1922. The complex ore containing copper, lead, silver, zinc, and iron was treated by table and flotation concentration at the rate of about 200 tons a day. The output from this property was the largest in the district and the county. The Hidden Treasure, Buffalo, Magnolia, Lion Hill, Kearsarge, Ophir, and Northern Light mines also produced ore of shipping grade.

*Rush Valley district (Stockton).*—Of the six producers in the Rush Valley district the Bullion Coalition mine, operated almost entirely by lessees, was the largest. Some of the ore from this property was shipped to the plant of the Utah Zinc Co., but most of the output was

lead ore smelted near Salt Lake City. The Galena King mine was an important producer of lead ore containing silver. This property was operated by the Keystone Development Co. Smaller lots of ore were shipped from the Muerbrook and Ben Harrison mines.

*Silver Islet district.*—Mining property adjoining the Gethin Leroy claims is under development by the Utah-Silver Lake Mining Co. One lot of ore containing 18 per cent of lead and 90 ounces of silver to the ton was shipped during the last part of December.

*Wild Cat Range district.*—Copper ore containing silver was shipped from the Silver Queen mine, leased to the Fluorite Mines Co. This company has considerable high-grade fluorite suitable for chemical works, part of which is at the mine and part awaiting shipment at Clive, the loading station on the Western Pacific Railroad.

## UTAH COUNTY.

*American Fork district.*—Five producers in the American Fork district reported an output of 539 tons of ore, of which 374 tons was of shipping grade and 165 tons was treated in a concentration mill and yielded silver-lead concentrate. The total output was valued at $24,183, or $44.87 a ton. The principal part of the output was produced from the Live Yankee and Silver Wave properties. Concentrating ore from the Silver Bell property was shipped to a custom mill near Murray. Two cars of silver-lead ore were shipped to the smelter from the Pittsburg property. Mine operations were discontinued shortly after the installation of a poorly constructed aerial tramway, which was designed to carry the ore to the bins on the flat below the mine. The Blue Rock mine produced one lot of lead ore containing a little silver.

*Mine production of gold, silver, copper, lead, and zinc in American Fork district, Utah, 1921–22.*

| Year. | Number of producers. | Ore. | Gold. | Silver. | Copper. | Lead. | Recoverable zinc. | Total value. |
|---|---|---|---|---|---|---|---|---|
| | | *Short tons.* | | *Fine ounces.* | *Pounds.* | *Pounds.* | *Pounds.* | |
| 1921 | 3 | 255 | $4,101 | 1,813 | 15,314 | 25,618 | ..... | $9,043 |
| 1922 | 5 | 539 | 6,926 | 7,306 | 31,081 | 104,629 | ..... | 24,183 |
| Increase, 1922 | 2 | 284 | 2,825 | 5,493 | 15,767 | 79,011 | ..... | 15,140 |
| Total, 1870-1922 | ..... | 77,051 | 284,306 | 1,933,459 | 224,265 | 30,203,369 | 46,911 | 4,076,418 |

*Tintic district.*—The most important producers on the Utah County side of the Tintic district were the Tintic Standard, Colorado Consolidated, Sioux, May Day, Uncle Sam, and Yankee properties. Late in the year the Iron King Consolidated Mining Co. resumed the shipment of iron ore used as a flux at the smelters.

## WASHINGTON COUNTY.

Only assessment work was done during the year at the Silver Reef property, in the Harrisburg district, but a little silver bullion obtained from laboratory tests was shipped to the mint.

# GOLD, SILVER, COPPER, LEAD, AND ZINC IN CALIFORNIA.

(MINES REPORT.)

By James M. Hill.[1]

## PRODUCTION.

The gold, silver, copper, lead, and zinc produced in California in 1922 showed an increase of nearly 2 per cent in total value as compared with the value in 1922. The increase was due to increased output of copper, lead, and zinc, for the gold and silver produced in 1922 were valued at $1,563,634 less than in 1921. The value of all metals produced in 1922 at deep mines increased 24 per cent, but the output of gold and silver from placer mines decreased about 33 per cent, as compared with 1921.

*Mine production of gold, silver, copper, lead, and zinc in California, 1918–1922.*

| Year. | Number of producing mines. | Ore. | Gold.[a] | Silver.[a] | Copper. | Lead. | Zinc. | Total value. |
|---|---|---|---|---|---|---|---|---|
| | | *Short tons.* | | *Fine ounces.* | *Pounds.* | *Pounds.* | *Pounds.* | |
| 1918 | 703 | 2,503,411 | $16,528,953 | 1,427,711 | 47,674,660 | 13,372,049 | 5,561,393 | $31,187,807 |
| 1919 | 650 | 1,714,911 | 16,695,955 | 1,107,189 | 21,732,507 | 3,568,267 | 472,990 | 22,201,898 |
| 1920 | 500 | 1,165,022 | 14,311,043 | 1,706,327 | 12,626,272 | 4,813,510 | 1,165,509 | 18,973,660 |
| 1921 | 573 | 1,215,600 | 15,704,822 | 3,629,223 | 11,743,404 | 1,124,276 | 1,057,731 | 20,952,423 |
| 1922 | 565 | 1,539,933 | 14,670,346 | 3,100,065 | 22,539,485 | 6,312,536 | 3,012,950 | 21,332,168 |
| Increase or decrease, 1922 | −8 | +324,333 | −1,034,476 | −529,158 | +10,796,081 | +5,188,260 | +1,955,219 | +379,745 |

[a] Includes placer production.

*Gold and silver produced at placer mines in California, 1918–1922.*

| Year. | Dredges. | | Drift. | | Hydraulic. | | Surface. | | Total value. |
|---|---|---|---|---|---|---|---|---|---|
| | Gold. | Silver. | Gold. | Silver. | Gold. | Silver. | Gold. | Silver. | |
| | | *Fine ounces.* | | *Fine ounces.* | | *Fine ounces.* | | *Fine ounces.* | |
| 1918 | $7,431,927 | 27,541 | $108,420 | 575 | $213,229 | 1,202 | $85,203 | 591 | $7,868,688 |
| 1919 | 7,716,919 | 25,741 | 85,341 | 558 | 184,832 | 1,270 | 45,984 | 355 | 8,064,351 |
| 1920 | 6,900,366 | 28,918 | 62,925 | 374 | 66,233 | 413 | 31,089 | 195 | 7,093,204 |
| 1921 | 7,756,787 | 36,322 | 127,411 | 615 | 162,808 | 864 | 107,818 | 829 | 8,193,454 |
| 1922 | 4,999,215 | 16,608 | 252,626 | 1,391 | 158,275 | 906 | 89,739 | 708 | 5,519,468 |
| Increase or decrease, 1922 | −2,757,572 | −19,714 | +125,215 | +776 | −4,533 | +42 | −18,079 | −121 | −2,673,986 |

[1] Miss Helen M. Gaylord, of the U. S. Geological Survey, assisted in the preparation of this report.

## ORE.

The quantity of copper ore mined in California in 1922 was 46 per cent greater than in 1921, lead ore 571 per cent, dry gold ore 14 per cent, and dry silver ore 73 per cent. The average value of all ore mined in the State was $10.27 a ton, as compared with $10.50 in 1921.

*Ore and metals produced in California in 1922.*

| Source of production. | Ore. | | Gold. | | Silver. | |
|---|---|---|---|---|---|---|
| | Short tons. | Per cent. | Fine ounces. | Per cent. | Fine ounces. | Per cent. |
| Dry gold ore | 984,785 | 63.95 | 430,809.45 | 60.71 | 97,128 | 3.13 |
| Dry silver ore | 67,363 | 4.38 | 5,092.94 | .72 | 2,375,361 | 76.62 |
| Copper ore | 447,200 | 29.04 | 5,728.85 | .81 | 320,977 | 10.35 |
| Copper-lead ore | 47 | ..... | 9.95 | ..... | 7,915 | .26 |
| Lead ore | 26,466 | 1.72 | 1,451.81 | .20 | 263,681 | 8.51 |
| Zinc ore | 14,072 | .91 | 529.48 | .07 | 15,390 | .50 |
| Total deep mines | 1,539,933 | 100.00 | 443,622.48 | 62.51 | 3,080,452 | 99.37 |
| Total placers | ..... | ..... | 266,055.51 | 37.49 | 19,613 | .63 |
| Total, deep mines and placers, 1922 | 1,539,933 | 100.00 | 709,677.99 | 100.00 | 3,100,065 | 100.00 |
| Total, deep mines and placers, 1921 | 1,215,600 | ..... | 759,720.76 | ..... | 3,629,223 | ..... |
| Increase or decrease, 1922 | +324,333 | ..... | −50,042.77 | ..... | −529,158 | ..... |

| Source of production. | Copper. | | Lead. | | Zinc. | |
|---|---|---|---|---|---|---|
| | Pounds. | Per cent. | Pounds. | Per cent. | Pounds. | Per cent |
| Dry gold ore | 3,296 | 0.02 | 1,981 | 0.03 | ..... | ..... |
| Dry silver ore | 7,514 | .03 | 215 | ..... | ..... | ..... |
| Copper ore | 21,845,111 | 96.92 | 214 | ..... | ..... | ..... |
| Copper-lead ore | 4,138 | .02 | 4,294 | .07 | ..... | ..... |
| Lead ore | 65,944 | .29 | 6,305,832 | 99.90 | ..... | ..... |
| Zinc ore | 613,482 | 2.72 | ..... | ..... | 3,012,950 | 100.00 |
| Total deep mines | 22,539,485 | 100.00 | 6,312,536 | 100.00 | 3,012,950 | 100.00 |
| Total deep mines, 1921 | 11,743,404 | ..... | 1,124,276 | ..... | 1,057,731 | ..... |
| Increase, 1922 | 10,796,081 | ..... | 5,188,260 | ..... | 1,955,219 | ..... |

*Value of ore mined and treated in California in 1922.*

| Kind of ore. | Ore (short tons). | Total value. | | Average value per ton | |
|---|---|---|---|---|---|
| | | In gold and silver. | In all metals. | In gold and silver. | In all metals. |
| Dry gold ore | 984,785 | $9,002,749 | $9,003,304 | $9.14 | $9.1 |
| Dry silver ore | 67,363 | 2,480,642 | 2,481,668 | 36.82 | 36.8 |
| Copper ore | 447,200 | 439,403 | 3,388,504 | .98 | 7.5 |
| Copper-lead ore | 47 | 8,121 | 8,916 | 172.79 | 189.7 |
| Lead ore | 26,466 | 293,693 | 649,415 | 11.10 | 24.5 |
| Zinc ore | 14,072 | 26,335 | 280,893 | 1.87 | 19.9 |
| | 1,539,933 | 12,250,943 | 15,812,700 | 7.96 | 10.2 |

During 1922 there were 936,132 tons of ore and 9,125 tons o concentrates milled at amalgamation and cyanidation plants, an 57,669 tons of ore and 49,469 tons of concentrates were sent to smelters

The recovery by cyanidation in 1922 was 42,444.60 ounces of gol and 38,544 ounces of silver, an increase of 4,344.42 ounces of gol

and 25,815 ounces of silver, as compared with the recovery at cyanidation plants in California in 1921.

The quantity of concentrates produced in 1922 was 77 per cent greater than in 1921, and the yield of metals from concentrates increased as follows: Gold 36 per cent, silver 453 per cent, copper 72 per cent, lead 1,175 per cent. The ores sent direct to smelters in 1922 yielded 26 per cent less gold and 42 per cent less silver, but 1,619 per cent more copper, 405 per cent more lead, and 160 per cent more zinc than in 1921.

Information was not given by a sufficient number of the mining companies in the State to make possible a statement concerning the consumption of quicksilver or cyanide at gold and silver mills.

*Content of ores sold or treated in California in 1922.*

**Dry gold ores.**

| County. | Ore. | Gold. | Silver. | Copper. | Lead. | Zinc. |
|---|---|---|---|---|---|---|
| | *Short tons.* | *Fine ounces.* | *Fine ounces.* | *Pounds.* | *Pounds.* | *Pounds.* |
| Amador | 340,335 | 106,689.26 | 32,039 | | | |
| Butte | 7 | 75.67 | 15 | | | |
| Calaveras | 206,485 | 58,975.67 | 10,970 | | | |
| Colusa | 10 | 8.76 | 3 | | | |
| Eldorado | 2,160 | 1,078.15 | 183 | | | |
| Fresno | 73 | 27.11 | 2 | | | |
| Imperial | 1 | 3.50 | 21 | | | |
| Inyo | 8,190 | 2,692.74 | 400 | 2,714 | | |
| Kern | 12,248 | 5,876.89 | 6,471 | | | |
| Lassen | 2,775 | 804.67 | 443 | | | |
| Los Angeles | 100 | 24.41 | 7 | | | |
| Madera | 85 | 47.42 | 38 | | | |
| Mariposa | 15,532 | 10,369.05 | 3,257 | | | |
| Merced | 1 | 13.91 | 1 | | | |
| Mono | 1,551 | 3,169.55 | 2,823 | | | |
| Nevada | 268,640 | 137,220.47 | 19,314 | 429 | 1,981 | |
| Placer | 4,061 | 2,256.36 | 510 | | | |
| Plumas | 3,875 | 1,378.20 | 186 | | | |
| San Bernardino | 4,453 | 956.33 | 756 | | | |
| San Diego | 184 | 147.50 | 561 | | | |
| Shasta | 3,385 | 2,937.53 | 1,444 | 162 | | |
| Sierra | 56,755 | 83,043.49 | 14,323 | | | |
| Siskiyou | 2,500 | 2,070.24 | 334 | | | |
| Trinity | 452 | 662.31 | 99 | | | |
| Tuolumne | 50,927 | 10,280.26 | 2,928 | | | |
| Total, 1922 [a] | 984,785 | 430,809.45 | 97,128 | 3,296 | 1,981 | |
| Total, 1921 | [b] 863,720 | 353,993.36 | [b] 108,603 | 9,878 | 640 | |
| Increase or decrease, 1922 | +121,065 | +76,816.09 | −11,475 | −6,582 | +1,341 | |

**Dry silver ores.**

| | | | | | | |
|---|---|---|---|---|---|---|
| Imperial | 7,500 | 1.73 | 16,987 | | | |
| Inyo | 2 | 4.02 | 237 | | | |
| Madera | 22 | | 3,451 | | | |
| San Bernardino | 59,839 | 5,087.19 | 2,354,686 | 7,514 | 215 | |
| Total, 1922 [c] | 67,363 | 5,092.94 | 2,375,361 | 7,514 | 215 | |
| Total, 1921 | [b] 38,846 | 8,940.86 | [b] 3,220,927 | | | |
| Increase or decrease, 1922 | +28,517 | −3,847.92 | −845,566 | +7,514 | +215 | |

[a] Includes gold and silver from 4,400 tons of tailings.
[b] Revised figures.
[c] Includes gold and silver from 7,600 tons of tailings.

*Content of ores sold or treated in California in 1922*—Continued.

**Copper ores.**

| County. | Ore. | Gold. | Silver. | Copper. | Lead. | Zinc. |
|---|---|---|---|---|---|---|
| | *Short tons.* | *Fine ounces.* | *Fine ounces.* | *Pounds.* | *Pounds.* | *Pounds.* |
| Plumas | 434,961 | 5,488.06 | 296,578 | 20,677,771 | ..... | ..... |
| San Bernardino | 48 | 18.81 | 14,485 | 5,438 | 214 | ..... |
| Shasta | 11,000 | 165.98 | 8,425 | 1,119,780 | ..... | ..... |
| Trinity | 1,191 | 56.00 | 1,489 | 42,122 | ..... | ..... |
| Total, 1922[a] | 447,200 | 5,728.85 | 320,977 | 21,845,111 | 214 | ..... |
| Total, 1921 | 306,134 | 1,439.01 | 175,870 | [b]11,599,540 | ..... | ..... |
| Increase, 1922 | 141,066 | 4,289.84 | 145,107 | 10,245,571 | 214 | ..... |

**Copper-lead ores.**

| | | | | | | |
|---|---|---|---|---|---|---|
| Mono | 46 | 9.95 | 7,761 | 3,976 | 4,191 | ..... |
| San Bernardino | 1 | ..... | 154 | 162 | 103 | ..... |
| Total, 1922 | 47 | 9.95 | 7,915 | 4,138 | 4,294 | ..... |
| Total, 1921 | ..... | ..... | ..... | ..... | ..... | ..... |
| Increase, 1922 | 47 | 9.95 | 7,915 | 4,138 | 4,294 | ..... |

**Lead ores.**

| | | | | | | |
|---|---|---|---|---|---|---|
| Imperial | 30 | ..... | 1,013 | ..... | 13,315 | ..... |
| Inyo | 26,374 | 1,427.92 | 255,372 | 65,868 | 6,270,121 | ..... |
| Mono | 1 | 1.00 | 1,102 | ..... | 5,583 | ..... |
| Orange | 21 | 3.14 | 1,327 | ..... | 5,025 | ..... |
| San Bernardino | 40 | 19.75 | 4,867 | 76 | 11,788 | ..... |
| Total, 1922 | 26,466 | 1,451.81 | 263,681 | 65,944 | 6,305,832 | ..... |
| Total, 1921 | 3,947 | 806.93 | 82,267 | 34,853 | 1,123,636 | ..... |
| Increase, 1922 | 22,519 | 644.88 | 181,414 | 31,091 | 5,182,196 | ..... |

**Zinc ores.**

| | | | | | | |
|---|---|---|---|---|---|---|
| Inyo | 104 | ..... | ..... | ..... | ..... | 58,700 |
| Shasta | 13,968 | 529.48 | 15,390 | 613,482 | ..... | 2,954,250 |
| Total, 1922 | 14,072 | 529.48 | 15,390 | 613,482 | ..... | 3,012,950 |
| Total, 1921 | 2,953 | 50.99 | 2,926 | 99,133 | ..... | 1,057,731 |
| Increase, 1922 | 11,119 | 478.49 | 12,464 | 514,349 | ..... | 1,955,219 |

[a] Includes gold, silver, and copper from tailings. [b] Revised figures.

## GOLD.

The accrediting of the gold reported as produced in California to the several counties and to placers and deep mines is difficult, for much of the gold reaches the mint and smelters with no means of identifying its origin. A large part of this gold is won by small mine owners who do not respond to the Geological Survey's inquiries, and a considerable part is without doubt the result of operations by "high-graders." Bankers and storekeepers at such centers as Sonora, Angels Camp, Jackson, Nevada City, Grass Valley, Oroville, Redding, and Yreka purchase or ship gold that comes from a considerable territory tributary to those towns, and often no record is kept of the persons for whom the bullion is handled or of its origin. These lots are usually small, but in the course of a year they aggregate a

considerable number of ounces, which must be accredited according to the Survey's best judgment.

In 1922 deep mines produced 62.5 per cent and placer mines 37.5 per cent of the gold output. In 1921 the relative proportion was deep mines 48 per cent and placers 52 per cent, and in 1920 deep mines produced 51 per cent and placer mines 49 per cent. Most of the 282 placer mines operated in California in 1922 were relatively small. Aside from the dredges there were only 2 placers, both drift mines, at which more than $20,000 in gold was recovered.

The placer gold yield in 1922 was valued at $5,499,855, or $2,654,969 less than the corresponding value in 1921. Dredges produced about 91 per cent, drift mines 5 per cent, hydraulic mines 3 per cent, and surface placers 1 per cent of the total. During the year there were 35 dredges, 63 drift, 60 hydraulic, and 124 surface placers at which gold was produced. Dredges in 1922 produced $2,757,572 less gold than in 1921; the greater part of the decrease was in the Yuba River field in Yuba County, but the dredges in Amador, Calaveras, Placer, Sacramento, and Trinity counties all produced smaller quantities. The dredges in Butte, Stanislaus, and Shasta counties recovered more gold in 1922 than in 1921.

The gold produced at drift mines in 1922 was $125,215 greater than in 1921, and the principal increase was in Plumas, Butte, Nevada, and Calaveras counties. There was a net decrease of $4,533 in the gold yield from hydraulic mines; decreases in Trinity and Siskiyou counties, but increases in Amador, Calaveras, Nevada, Plumas, and Sierra counties. The production of gold from surface mines in 1922 was $18,079 less than in 1921. The output from this source varies considerably from year to year, depending largely on labor conditions.

The production of gold from deep mines in 1922 was valued at $9,170,491, an increase of $1,620,493 as compared with the corresponding yield in 1921. Of the 283 deep mines that produced gold in 1922, only 31 yielded more than $20,000 worth of gold and only 7 more than $400,000 worth. At 4 deep mines the gold produced exceeded $1,000,000. Nevada County was first in gold yield from deep mines, the value being over $2,800,000; in Amador County it was over $2,200,000; Sierra County yielded over $1,700,000; and Calaveras County over $1,200,000. The next in rank were Mariposa County, with $214,000, and Tuolumne County, with $212,000. There were material increases in the output of gold produced at deep mines in Amador, Mono, Nevada, Plumas, Shasta, Sierra, Siskiyou, and Tuolumne counties, but the most noteworthy gain was in the Alleghany district in Sierra County. The mines at Nevada City and Grass Valley were more productive than in 1921, and the output of gold from Jackson, Amador County, showed no decrease, notwithstanding the fire at the Argonaut mine.

The dry gold ores mined in 1922, a total of 984,785 tons, yielded 97 per cent of the gold produced at deep mines and 61 per cent of the total gold produced at both deep and placer mines. Dry silver and copper ores each carried more than 1 per cent of the gold from deep mines. Bullion made at gold and silver mills carried 84 per cent, concentrates made at all classes of mills more than 14 per cent, and smelting ore nearly 2 per cent of the total gold produced by deep mines in 1922.

## SILVER.

The decrease of silver output in California in 1922 was due largely to the decreased shipments from the Randsburg district, in San Bernardino County, for much more silver was produced from the lead ores of Inyo County and the copper ores of Plumas County than in 1921. The decrease in San Bernardino County was 835,754 ounces.

The output of silver from placer mines in 1922 was 19,613 ounces, about half that of 1921, and the decrease was practically all in the output from dredge operations, which produced 16,608 ounces in 1922, as compared with 36,322 ounces in 1921. There were slight increases in silver output from drift and hydraulic mines, but surface placers produced less than in 1921.

The production of silver from deep mines was 510,141 ounces less than in 1921. The Kelly mine, at Randsburg, was by far the largest producer of silver in the State, and San Bernardino County produced 77 per cent of the total deep-mine output. The copper ores mined in Plumas County carried the second largest quantity, and the lead ores mined in Inyo County the third largest quantity of silver produced at deep mines. Dry silver ores mined in 1922 yielded 77 per cent, copper ores 10 per cent, lead ore 9 per cent, and dry gold ore 3 per cent of the total deep-mine silver output of the State. The recovery at gold and silver mills was 3 per cent, concentrates produced at all types of mills carried nearly 35 per cent, and ore sent direct to smelters 62 per cent of the silver output of California in 1922.

## COPPER.

The output of copper at California mines in 1922 was valued at $3,042,830, an increase of $1,527,931, as compared with 1921. The increase was due largely to increased activity at the Engels and Walker mines, in Plumas County, though a considerable quantity of copper was recovered from Shasta County ores. Trinity County again produced copper, owing to the resumption of mining at the Island Mountain mine. The output of copper from Inyo and Mono counties was larger than in 1921, but less copper was produced in San Bernardino County.

In 1922 copper ores yielded approximately 97 per cent and zinc ores nearly 3 per cent of the copper produced in California. Of the total output, 88 per cent was recovered by smelting concentrates and 12 per cent by the smelting of crude ore.

## LEAD.

The production of lead at California mines in 1922 was valued at $347,189, an increase of $296,597 as compared with 1921. This great increase was due to the resumption of lead mining in Inyo County, whose mines increased their yield practically 500 per cent. The principal producers were the Tecopa, Darwin, and Cerro Gordo mines. A small quantity of lead was contained in ore mined in Imperial, Orange, Mono, and San Bernardino counties, and a little lead was recovered from concentrates produced at Nevada County mines.

Practically all the lead produced in California in 1922 (99.9 per cent) was recovered from lead ores. Crude ore smelted yielded 83 per cent and concentrates nearly 17 per cent of the total lead output.

## ZINC.

The output of zinc in California in 1922 was valued at $171,738, an increase of $118,851 as compared with 1921. The increase in quantity was 185 per cent. Of the zinc produced in the State, 98 per cent was recovered in the form of zinc oxide at the plant of the Shasta Zinc & Copper Co. at Winthrop. The Shasta County zinc ore carried considerable gold, silver, and copper, which are recovered in copper matte.

## METALLURGICAL INDUSTRY.

*Gold and silver produced at mills in California, 1921–1922.*

| County. | Ore to gold and silver mills. | Gold in bullion. | Silver in bullion. | Ore to concentrating mills. |
|---|---|---|---|---|
| | *Short tons.* | *Fine ounces.* | *Fine ounces.* | *Short tons.* |
| Amador | 336,564 | 78,244.14 | 18,343 | ..... |
| Butte | 7 | 75.67 | 15 | ..... |
| Calaveras | 206,485 | 44,318.50 | 6,604 | ..... |
| Colusa | 10 | 8.76 | 3 | ..... |
| Eldorado | 2,160 | 1,078.15 | 183 | ..... |
| Fresno | 73 | 27.11 | 2 | ..... |
| Imperial | 7,500 | 1.73 | 16,987 | ..... |
| Inyo | 1,525 | 655.03 | 188 | 21,884 |
| Kern | 12,248 | 5,806.22 | 6,262 | ..... |
| Lassen | 2,775 | 804.67 | 443 | ..... |
| Los Angeles | 100 | 24.41 | 7 | ..... |
| Madera | 85 | 47.42 | 38 | ..... |
| Mariposa | 15,532 | 9,542.46 | 2,572 | ..... |
| Merced | 1 | 13.91 | 1 | ..... |
| Mono | 523 | 596.00 | 1,347 | 1,000 |
| Nevada | 268,634 | 136,079.81 | 17,751 | ..... |
| Placer | 4,061 | 2,223.38 | 499 | ..... |
| Plumas | 3,875 | 1,378.20 | 186 | 431,601 |
| San Bernardino | 4,950 | 856.45 | 5,306 | 46,476 |
| San Diego | 183 | 136.15 | 57 | ..... |
| Shasta | 3,381 | 2,725.39 | 675 | ..... |
| Sierra | 56,755 | 82,343.47 | 14,136 | ..... |
| Siskiyou | 2,500 | 1,967.40 | 315 | ..... |
| Trinity | 452 | 662.31 | 99 | ..... |
| Tuolumne | 5,753 | 2,863.53 | 734 | 45,171 |
| Total, 1922 [a] | 936,132 | 372,480.27 | 92,753 | 546,132 |
| Total, 1921 [a] | 854,458 | 308,001.64 | 95,324 | 317,493 |
| Increase or decrease, 1922 | +81,674 | +64,478.63 | −2,571 | +228,639 |
| Average content per ton, 1922 | ..... | 0.3978 | 0.0991 | ..... |

[a] Includes old tailings milled.

*Metallurgical recovery of metals in California in 1922.*

| Process. | Material treated. | Metals recovered. | | | | |
|---|---|---|---|---|---|---|
| | | Gold. | Silver. | Copper. | Lead. | Zinc. |
| Gold and silver mills: | *Short tons.* | *Fine ounces.* | *Fine ounces.* | *Pounds.* | *Pounds.* | *Pounds.* |
| Ore amalgamated | 936,132 | 351,104.82 | 60,303 | ..... | ..... | ..... |
| Ore cyanided | | 21,375.45 | 32,450 | ..... | ..... | ..... |
| Concentrates cyanided | 9,125 | 21,069.15 | 6,094 | ..... | ..... | ..... |
| Smelted: | | | | | | |
| Ore | 57,669 | 7,878.54 | 1,909,680 | 2,625,686 | 5,260,325 | 3,012,950 |
| Concentrates | 49,469 | 42,194.52 | 1,071,925 | 19,913,799 | 1,052,211 | ..... |
| | ..... | 443,622.48 | 3,080,452 | 22,539,485 | 6,312,536 | 3,012,950 |

*Metals produced from California concentrates in 1922.*

**By counties.**

| | Concentrates. | Gold. | Silver. | Copper. | Lead. |
|---|---|---|---|---|---|
| | *Short tons.* | *Fine ounces.* | *Fine ounces.* | *Pounds.* | *Pounds.* |
| Amador | 5,840 | 26,844.04 | 7,833 | ..... | ..... |
| Calaveras | 5,597 | 14,657.17 | 4,366 | ..... | ..... |
| Inyo | 1,705 | 2,116.24 | 99,434 | 22,781 | 1,050,2 |
| Kern | 34 | 70.67 | 209 | ..... | ..... |
| Mariposa | 167 | 826.59 | 685 | ..... | ..... |
| Mono | 49 | 1,890.00 | 298 | ..... | ..... |
| Nevada | 164 | 1,120.51 | 1,512 | 420 | 1,9 |
| Placer | 5 | 32.98 | 11 | ..... | ..... |
| Plumas | 39,167 | 5,207.64 | 285,283 | 19,890,598 | ..... |
| San Bernardino | 1,975 | 2,097.00 | 675,916 | ..... | ..... |
| Shasta | 50 | 211.65 | 95 | ..... | ..... |
| Sierra | 63 | 700.02 | 187 | ..... | ..... |
| Siskiyou | 16 | 102.84 | 19 | ..... | ..... |
| Tuolumne | 3,762 | 7,386.32 | 2,171 | ..... | ..... |
| Total, 1922 | 58,594 | 63,263.67 | 1,078,019 | 19,913,799 | 1,052,2 |
| Total, 1921 | 33,062 | 46,619.81 | 194,854 | 11,590,633 | 82,5 |
| Increase, 1922 | 25,532 | 16,643.86 | 883,165 | 8,323,166 | 969,7 |

**By kinds of concentrates.**

| | | | | | |
|---|---|---|---|---|---|
| Dry gold | 16,014 | 55,880.50 | 17,598 | 3,134 | 1,9 |
| Dry silver | 1,975 | 2,097.00 | 675,916 | ..... | ..... |
| Copper | 39,167 | 5,207.64 | 285,283 | 19,890,598 | ..... |
| Lead | 1,438 | 78.53 | 99,222 | 20,067 | 1,050,2 |
| | 58,594 | 63,263.67 | 1,078,019 | 19,913,799 | 1,052,2 |

**Average content.**

| | Gold. | Silver. | Copper. | Lead. |
|---|---|---|---|---|
| | *Fine ounces per ton.* | *Fine ounces per ton.* | *Per cent.* | *Per cent* |
| Dry gold | 3.49 | 1.10 | 0.01 | 0.0 |
| Dry silver | 1.06 | 342.23 | ..... | ..... |
| Copper | .13 | 7.28 | 25.39 | ..... |
| Lead | .05 | 69.00 | .70 | 36. |
| Average | 1.08 | 18.40 | 16.99 | . |

*Mine production of metals from California crude ores shipped to smelters in 1922.*

**By counties.**

| County. | Crude ore. | Gold. | Silver. | Copper. | Lead. | Zinc. |
|---|---|---|---|---|---|---|
| | *Short tons.* | *Fine ounces.* | *Fine ounces.* | *Pounds.* | *Pounds.* | *Pounds* |
| Amador | 3,771 | 1,601.08 | 5,863 | ..... | ..... | ..... |
| Imperial | 31 | 3.50 | 1,034 | ..... | 13,315 | ..... |
| Inyo | 11,261 | 1,353.41 | 156,387 | 45,801 | 5,219,891 | 58,7 |
| Madera | 22 | ..... | 3,451 | ..... | ..... | ..... |
| Mono | 75 | 694.50 | 10,041 | 3,976 | 9,774 | ..... |
| Nevada | 6 | 20.15 | 51 | ..... | ..... | ..... |
| Orange | 21 | 3.14 | 1,327 | ..... | 5,025 | ..... |
| Plumas | 3,360 | 280.42 | 11,295 | 787,173 | ..... | ..... |
| San Bernardino | 12,955 | 3,128.63 | 1,693,726 | 13,190 | 12,320 | ..... |
| San Diego | 1 | 11.35 | 504 | ..... | ..... | ..... |
| Shasta | 24,972 | 695.95 | 24,489 | 1,733,424 | ..... | 2,954,4 |
| Trinity | 1,191 | 56.00 | 1,489 | 42,122 | ..... | ..... |
| Tuolumne | 3 | 30.41 | 23 | ..... | ..... | ..... |
| Total, 1922 [a] | 57,669 | 7,878.54 | 1,909,680 | 2,625,686 | 5,260,325 | 3,012,6 |
| Total, 1921 | 43,649 | 10,609.70 | 3,300,415 | 152,771 | 1,041,773 | 1,057,7 |
| Increase or decrease, 1922 | +14,020 | −2,731.16 | −1,390,735 | +2,472,915 | +4,218,552 | +1,955,1 |

[a] Includes gold, silver, and copper recovered from tailings.

*Mine production of metals from California crude ores shipped to smelters in 1922*—Con.

**By kinds of ore.**

| Kind of ore. | Crude ore. | Gold. | Silver. | Copper. | Lead. | Zinc. |
|---|---|---|---|---|---|---|
| | *Short tons.* | *Fine ounces.* | *Fine ounces.* | *Pounds.* | *Pounds.* | *Pounds.* |
| Dry gold ore | 3,857 | 2,454.31 | 8,675 | 162 | ..... | ..... |
| Dry silver ore | 12,847 | 2,990.31 | 1,677,547 | 7,514 | 215 | ..... |
| Copper ore | 15,599 | 521.21 | 35,694 | 1,954,513 | 214 | ..... |
| Copper-lead ore | 47 | 9.95 | 7,915 | 4,138 | 4,294 | ..... |
| Lead ore | 11,247 | 1,373.28 | 164,459 | 45,877 | 5,255,602 | ..... |
| Zinc ore | 14,072 | 529.48 | 15,390 | 613,482 | ..... | 3,012,950 |
| | 57,669 | 7,878.54 | 1,909,680 | 2,625,686 | 5,260,325 | 3,012,950 |

**Average content.**

| Kind of ore. | Gold. | Silver. | Copper. | Lead. | Zinc. |
|---|---|---|---|---|---|
| | *Fine ounces per ton.* | *Fine ounces per ton.* | *Per cent.* | *Per cent.* | *Per cent.* |
| Dry gold ore | 0.64 | 2.25 | ..... | ..... | ..... |
| Dry silver ore | .23 | 130.58 | 0.03 | ..... | ..... |
| Copper ore | .03 | 2.29 | 6.26 | ..... | ..... |
| Copper-lead ore | .21 | 168.40 | 4.40 | 4.57 | ..... |
| Lead ore | .12 | 14.62 | .20 | 23.36 | ..... |
| Zinc ore | .04 | 1.09 | 2.18 | ..... | 10.70 |
| Average | .14 | 33.11 | 2.28 | 4.56 | 2.61 |

## MINING INDUSTRY.

The mining industry was more active during 1922 than in the previous year, and considerable development work, which resulted in little or no production of metals, was accomplished in various parts of the State. The most notable features of the year were the revival of copper and lead mining. The copper mines in Plumas County, the Engels and Walker, doubled their output and continued development of new ore bodies and milling facilities. The Island Mountain copper mine, in Trinity County, began shipments late in the year, and preparations were made for early resumption of copper mining at the Mountain and Mammoth plants, in Shasta County, and at the Calaveras copper plant, at Copperopolis. The lead mines near Darwin and Cerro Gordo were much more actively worked than in 1921, though the output from these mines can still be increased. The notable increase in zinc production resulted almost entirely from the working of the zinc oxide plant at Winthrop, Shasta County, at which production was stopped in December, 1922.

Mining on the Mother Lode was more active than in 1921. The chief producing mines on the lode in 1922 were the Argonaut, Kennedy, Plymouth, Central Eureka, Bunker Hill, Treasure, and Moore, in Amador County; the Melones, Morning Star, Montacali, and Columbus, in Calaveras County; the Original and Virginia-Belmont, in Mariposa County; and the Belmont-Shawmut, in Tuolumne County. A disastrous fire at the Argonaut mine in August resulted in closing that mine for the rest of the year and curtailing the operations at the adjoining Kennedy mine. The average value of ore treated at gold and silver mills on the Mother Lode was greater than in 1921, owing in part to the large number of small producers of high-grade ore. In the table below the concentrates include only those made at gold and silver mills.

*Gold and silver produced at gold mills in Mother Lode counties in California in 1922.*

| County. | Ore treated (short tons). | | Gold and silver recovered in bullion. | | |
|---|---|---|---|---|---|
| | Total. | At gold milling plants. | Gold. | Silver (fine ounces). | Average per ton of ore. |
| Amador | 340,335 | 336,564 | $1,617,450 | 18,343 | $4.86 |
| Calaveras | 206,485 | 206,485 | 916,145 | 6,604 | 4.47 |
| Eldorado | 2,160 | 2,160 | 22,287 | 183 | 10.40 |
| Mariposa | 15,532 | 15,532 | 197,260 | 2,572 | 12.87 |
| Tuolumne | 50,927 | 5,753 | 59,194 | 734 | 10.42 |
| | 615,439 | 566,494 | 2,812,336 | 28,436 | 5.01 |

| County. | Concentrates produced (short tons). | Gold and silver recovered from concentrates. | | | Value of total recovery. | |
|---|---|---|---|---|---|---|
| | | Gold. | Silver (fine ounces). | Average per ton of concentrates. | Total. | Average per ton of ore. |
| Amador | 5,840 | $554,916 | 7,833 | $96.36 | $2,198,542 | $6.53 |
| Calaveras | 5,597 | 302,990 | 4,366 | 54.91 | 1,230,105 | 5.96 |
| Eldorado | | | | | 22,470 | 10.40 |
| Mariposa | 167 | 17,087 | 685 | 106.42 | 217,604 | 14.01 |
| Tuolumne | 43 | 1,579 | 86 | 38.72 | 61,593 | 10.71 |
| | 11,647 | 876,572 | 12,970 | 76.38 | 3,730,314 | 6.58 |

At Nevada City and Grass Valley there was much activity, but labor conditions were not particularly good, and the turnover was heavy. The North Star and Empire mines produced regularly, and the Idaho-Maryland began production after a considerable period of development. The Julia Ross and Newton mines were reopened.

Interest was shown in the reopening of the gold properties at French Gulch, Shasta County, and the Sybil, Gladstone, Brown Bear, and Washington mines were all productive during part of 1922.

Sierra County deep mines were third in rank as gold producers, largely because of the activity of the mines at Alleghany. The Sixteen-to-One, Tightner, and Eldorado had a large yield, and at least 10 other mines were worked more or less actively.

Revival of interest in the Salmon River country in western Siskiyou County was evident, and several hydraulic mines and some quartz properties near Forks of Salmon and Sawyers Bar were operated.

The placer mines of the State were not so productive as in 1921, and the yield of placer gold and silver has not been so low in years as it was in 1922. The principal decrease was in the recovery by dredges, though the same number of dredges were in operation as in 1921. The boat of the American Gold Dredging Co. on Mokelumne River, between Amador and Calaveras counties, finished its ground. The Valdor dredge, in Trinity County, was moved to new ground near Lewiston, and the boat of the Pacific Gold Dredging Co. at Carrville was dismantled. The Gardella interests built a new dredge at Lewiston and prospected additional ground near Minersville. The American Gold Dredging Co. sold its dredge at Applegate, near Colfax, Placer County, to local people, who continued operations. The Yuba Consolidated Gold Fields, Natomas Co. of California, American Gold

Dredging Co., and Marysville Gold Dredging Co. continued operating on about the usual scale, but the yield from the Yuba and American River fields was lower than in 1921.

Approximately 62,000,000 cubic yards of gravel was handled by the dredges in 1922, which indicates a recovery of 8.1 cents to the cubic yard. The consumption of quicksilver by dredges was about 7,500 pounds. The total production of gold by dredges since the beginning of the industry in 1896 has been $129,999,199, of which the Feather River field has produced $32,070,497, the Yuba River field $46,719,447, and the American River field $29,850,462.

Drift mining at Table Mountain, Butte County, showed some revival, but the greatest increase in gold production from drift mines was at the Feather Fork mine, in Plumas County, and the Quaker Hill drift, at Nevada City, Nevada County. At Foresthill, Iowa Hill, and Michigan Bluff, in Placer County, at Sierra City, Sierra County, and at Columbia, Tuolumne County, there was considerable development of old-channel gravels.

Hydraulic mining in Siskiyou and Trinity counties was limited by low water. The Yuba Construction Co. started the construction of a large dam at Ballards Bar, which will make possible the reopening of hydraulic mines on the North Fork of Yuba River.

*Mine production of gold, silver, copper, lead, and zinc in California in 1922.*

| County. | Ore treated (short tons). | Deep-mine gold. | | Placer gold. | | Total gold. | |
|---|---|---|---|---|---|---|---|
| | | Fine ounces. | Value. | Fine ounces. | Value. | Fine ounces. | Value. |
| Amador | 340,335 | 106,689.26 | $2,205,463 | 1,723.95 | $35,637 | 108,413.21 | $2,241,100 |
| Butte | 7 | 75.67 | 1,564 | 23,686.21 | 489,637 | 23,761.88 | 491,201 |
| Calaveras | 206,485 | 58,975.67 | 1,219,135 | 9,400.71 | 194,330 | 68,376.38 | 1,413,465 |
| Colusa, Del Norte, and Lassen [a] | 2,785 | 813.43 | 16,815 | 31.84 | 658 | 845.27 | 17,473 |
| Eldorado | 2,160 | 1,078.15 | 22,287 | 1,211.95 | 25,053 | 2,290.10 | 47,340 |
| Fresno | 73 | 27.11 | 560 | 478.02 | 9,882 | 505.13 | 10,442 |
| Humboldt | | | | 64.33 | 1,330 | 64.33 | 1,330 |
| Imperial | 7,531 | 5.23 | 108 | 11.74 | 242 | 16.97 | 350 |
| Inyo | 34,670 | 4,124.68 | 85,265 | | | 4,124.68 | 85,265 |
| Kern | 12,248 | 5,876.89 | 121,486 | 137.92 | 2,851 | 6,014.81 | 124,337 |
| Los Angeles, Orange, and San Diego [a] | 305 | 175.05 | 3,619 | 23.57 | 487 | 198.62 | 4,106 |
| Madera | 107 | 47.42 | 980 | 29.70 | 614 | 77.12 | 1 594 |
| Mariposa | 15 532 | 10,369.05 | 214,347 | 204.32 | 4,224 | 10,573.37 | 218,571 |
| Merced and Stanislaus [a] | 1 | 13.91 | 288 | 5,097.56 | 105,376 | 5,111.47 | 105,664 |
| Mono | 1,598 | 3,180.50 | 65,747 | | | 3,180.50 | 65,747 |
| Nevada | 268,640 | 137,220.47 | 2,836,599 | 3,239.85 | 66,974 | 140,460.32 | 2,903,573 |
| Placer | 4,061 | 2,256.36 | 46,643 | 3,532.86 | 73,030 | 5,789.22 | 119,673 |
| Plumas | 438,836 | 6,866.26 | 141,938 | 3,922.56 | 81,087 | 10,788.82 | 223,025 |
| Sacramento | | | | 65,342.50 | 1,350,749 | 65,342.50 | 1,350,749 |
| San Bernardino | 64,381 | 6,082.08 | 125,728 | | | 6,082.08 | 125,728 |
| Shasta | 28,353 | 3,632.99 | 75,101 | 15,380.00 | 317,933 | 19,012.99 | 393,034 |
| Sierra | 56,755 | 83,043.49 | 1,716,661 | 1,769.59 | 36,581 | 84,813.08 | 1,753,242 |
| Siskiyou | 2,500 | 2,070.24 | 42,796 | 1,562.93 | 32,309 | 3,633.17 | 75,105 |
| Trinity | 1,643 | 718.31 | 14,849 | 8,130.36 | 168,069 | 8,848.67 | 182,918 |
| Tuolumne | 50,927 | 10,280.26 | 212,512 | 476.70 | 9,854 | 10,756.96 | 222,366 |
| Yuba | | | | 120,596.34 | 2,492,948 | 120,596.34 | 2,492,948 |
| Total, 1922 | 1,539,933 | 443,622.48 | 9,170,491 | 266,055.51 | 5,499,855 | 709,677.99 | 14,670,346 |
| Total, 1921 | 1,215,600 | 365,231.15 | 7,549,998 | 394,489.61 | 8,154,824 | 759,720.76 | 15,704,822 |
| Increase or decrease, 1922 | +324,333 | +78,391.33 | +1,620,493 | −128,434.10 | −2,654,969 | −50,042.77 | −1,034,476 |

[a] Counties combined to avoid disclosure of individual output.

*Mine production of gold, silver, copper, lead, and zinc in California in 1922*—Contd.

| County. | Deep-mine silver. | | Placer silver. | | Total silver. | |
|---|---|---|---|---|---|---|
| | Fine ounces. | Value. | Fine ounces. | Value. | Fine ounces. | Value. |
| Amador | 32,039 | $32,039 | 248 | $248 | 32,287 | $32,287 |
| Butte | 15 | 15 | 1,875 | 1,875 | 1,890 | 1,890 |
| Calaveras | 10,970 | 10,970 | 678 | 678 | 11,648 | 11,648 |
| Colusa, Del Norte, and Lassen [a] | 446 | 446 | 3 | 3 | 449 | 449 |
| Eldorado | 183 | 183 | 193 | 193 | 376 | 376 |
| Fresno | 2 | 2 | 85 | 85 | 87 | 87 |
| Humboldt | | | 10 | 10 | 10 | 10 |
| Imperial | 18,021 | 18,021 | 3 | 3 | 18,024 | 18,024 |
| Inyo | 256,009 | 256,009 | | | 256,009 | 256,009 |
| Kern | 6,471 | 6,471 | 53 | 53 | 6,524 | 6,524 |
| Los Angeles, Orange, and San Diego [a] | 1,895 | 1,895 | 3 | 3 | 1,898 | 1,898 |
| Madera | 3,489 | 3,489 | 11 | 11 | 3,500 | 3,500 |
| Mariposa | 3,257 | 3,257 | 44 | 44 | 3,301 | 3,301 |
| Merced and Stanislaus [a] | 1 | 1 | 619 | 619 | 620 | 620 |
| Mono | 11,686 | 11,686 | | | 11,686 | 11,686 |
| Nevada | 19,314 | 19,314 | 269 | 269 | 19,583 | 19,583 |
| Placer | 510 | 510 | 442 | 442 | 952 | 952 |
| Plumas | 296,764 | 296,764 | 490 | 490 | 297,254 | 297,254 |
| Sacramento | | | 3,392 | 3,392 | 3,392 | 3,392 |
| San Bernardino | 2,374,948 | 2,374,948 | | | 2,374,948 | 2,374,948 |
| Shasta | 25,259 | 25,259 | 1,642 | 1,642 | 26,901 | 26,901 |
| Sierra | 14,323 | 14,323 | 161 | 161 | 14,484 | 14,484 |
| Siskiyou | 334 | 334 | 278 | 278 | 612 | 612 |
| Trinity | 1,588 | 1,588 | 844 | 844 | 2,432 | 2,432 |
| Tuolumne | 2,928 | 2,928 | 48 | 48 | 2,976 | 2,976 |
| Yuba | | | 8,222 | 8,222 | 8,222 | 8,222 |
| Total, 1922 | 3,080,452 | 3,080,452 | 19,613 | 19,613 | 3,100,065 | 3,100,065 |
| Total, 1921 | 3,590,593 | 3,590,593 | 38,630 | 38,630 | 3,629,223 | 3,629,223 |
| Decrease, 1922 | 510,141 | 510,141 | 19,017 | 19,017 | 529,158 | 529,158 |

| County. | Copper. | | Lead. | | Zinc. | | Total value. |
|---|---|---|---|---|---|---|---|
| | Pounds. | Value. | Pounds. | Value. | Pounds. | Value. | |
| Amador | | | | | | | $2,273,387 |
| Butte | | | | | | | 493,091 |
| Calaveras | | | | | | | 1,425,113 |
| Colusa, Del Norte, and Lassen [a] | | | | | | | 17,922 |
| Eldorado | | | | | | | 47,716 |
| Fresno | | | | | | | 10,529 |
| Humboldt | | | | | | | 1,340 |
| Imperial | | | 13,315 | $732 | | | 19,106 |
| Inyo | 68,582 | $9,259 | 6,270,121 | 344,857 | 58,700 | $3,346 | 698,736 |
| Kern | | | | | | | 130,861 |
| Los Angeles, Orange, and San Diego [a] | | | 5,025 | 276 | | | 6,280 |
| Madera | | | | | | | 5,094 |
| Mariposa | | | | | | | 221,872 |
| Merced and Stanislaus [a] | | | | | | | 106,284 |
| Mono | 3,976 | 537 | 9,774 | 537 | | | 78,507 |
| Nevada | 420 | 57 | 1,981 | 109 | | | 2,923,322 |
| Placer | | | | | | | 120,625 |
| Plumas | 20,677,771 | 2,791,499 | | | | | 3,311,778 |
| Sacramento | | | | | | | 1,354,141 |
| San Bernardino | 13,190 | 1,780 | 12,320 | 678 | | | 2,503,134 |
| Shasta | 1,733,424 | 234,012 | | | 2,954,250 | 168,392 | 822,339 |
| Sierra | | | | | | | 1,767,726 |
| Siskiyou | | | | | | | 75,717 |
| Trinity | 42,122 | 5,686 | | | | | 191,036 |
| Tuolumne | | | | | | | 225,342 |
| Yuba | | | | | | | 2,501,170 |
| Total, 1922 | 22,539,485 | 3,042,830 | 6,312,536 | 347,189 | 3,012,950 | 171,738 | 21,332,168 |
| Total, 1921 | 11,743,404 | 1,514,899 | 1,124,276 | 50,592 | 1,057,731 | 52,887 | 20,952,423 |
| Increase, 1922 | 10,796,081 | 1,527,931 | 5,188,260 | 296,597 | 1,955,219 | 118,851 | 379,745 |

[a] Counties combined to avoid disclosure of individual output.

*Placer output in California in 1922.*

| County. | Dredges. | | Drift. | | Hydraulic. | | Surface. | | Total value. |
|---|---|---|---|---|---|---|---|---|---|
| | Gold. | Silver. | Gold. | Silver. | Gold. | Silver. | Gold. | Silver. | |
| | | *Fine ounces.* | | *Fine ounces.* | | *Fine ounces.* | | *Fine ounces.* | |
| Amador | $4,661 | 27 | $411 | 6 | $27,073 | 183 | $3,492 | 32 | $35,885 |
| Butte | 454,294 | 1,661 | 33,382 | 202 | ..... | ..... | 1,961 | 12 | 491,512 |
| Calaveras | 145,505 | 396 | 33,738 | 163 | 10,152 | 93 | 4,935 | 26 | 195,008 |
| Del Norte | ..... | ..... | ..... | ..... | ..... | ..... | 658 | 3 | 661 |
| Eldorado | ..... | ..... | 8,589 | 64 | ..... | ..... | 16,464 | 129 | 25,246 |
| Fresno | ..... | ..... | ..... | ..... | ..... | ..... | 9,882 | 85 | 9,967 |
| Humboldt | ..... | ..... | ..... | ..... | 174 | 10 | 1,156 | ..... | 1,340 |
| Imperial | ..... | ..... | ..... | ..... | ..... | ..... | 242 | 3 | 245 |
| Kern | ..... | ..... | ..... | ..... | ..... | ..... | 2,851 | 53 | 2,904 |
| Madera | ..... | ..... | ..... | ..... | ..... | ..... | 614 | 11 | 625 |
| Mariposa | ..... | ..... | ..... | ..... | ..... | ..... | 4,224 | 44 | 4,268 |
| Merced | ..... | ..... | ..... | ..... | ..... | ..... | 381 | 5 | 386 |
| Nevada | ..... | ..... | 42,147 | 171 | 24,029 | 94 | 798 | 4 | 67,243 |
| Placer | 21,161 | 117 | 42,039 | 245 | ..... | ..... | 9,830 | 80 | 73,472 |
| Plumas | ..... | ..... | 66,302 | 404 | 7,120 | 35 | 7,665 | 51 | 81,577 |
| Sacramento | 1,349,413 | 3,385 | ..... | ..... | ..... | ..... | 1,336 | 7 | 1,354,141 |
| San Diego | ..... | ..... | ..... | ..... | ..... | ..... | 487 | 3 | 490 |
| Shasta | 307,885 | 1,576 | 275 | 2 | ..... | ..... | 9,773 | 64 | 319,575 |
| Sierra | ..... | ..... | 11,085 | 68 | 25,102 | 90 | 394 | 3 | 36,742 |
| Siskiyou | ..... | ..... | 683 | 5 | 26,828 | 236 | 4,798 | 37 | 32,587 |
| Stanislaus | 103,313 | 590 | ..... | ..... | ..... | ..... | 1,682 | 24 | 105,609 |
| Trinity | 127,578 | 666 | ..... | ..... | 37,344 | 162 | 3,147 | 16 | 168,913 |
| Tuolumne | ..... | ..... | 8,865 | 42 | ..... | ..... | 989 | 6 | 9,902 |
| Yuba | 2,485,405 | 8,190 | 5,110 | 19 | 453 | 3 | 1,980 | 10 | 2,501,170 |
| Total, 1922 | 4,999,215 | 16,608 | 252,626 | 1,391 | 158,275 | 906 | 89,739 | 708 | 5,519,468 |
| Total, 1921 | 7,756,787 | 36,322 | 127,411 | 615 | 162,808 | 864 | 107,818 | 829 | 8,193,454 |
| Increase or decrease, 1922 | −2,757,572 | −19,714 | +125,215 | +776 | −4,533 | +42 | −18,079 | −121 | −2,673,986 |

## REVIEW BY COUNTIES.

### AMADOR COUNTY.

During 1922 there were 14 deep mines and 11 placer mines in operation in Amador County, as compared with 23 deep mines and 8 placers in 1921.

The placer production of the county was 1,723.95 ounces of gold and 248 ounces of silver, valued at $35,885, as compared with $137,580 in 1921. The decrease was due largely to the fact that the Camanche No. 3 dredge was dismantled. Of the total placer gold produced 4 hydraulic mines recovered 76 per cent, 2 drift mines 1 per cent, 1 dredge 13 per cent, and 4 surface placers 10 per cent.

Amador County deep mines produced 340,335 tons of dry gold ore, which carried 106,689.26 ounces of gold and 32,039 ounces of silver, having a total value of $2,237,502, or approximately $6.57 a ton. These mines were the largest producers of gold and silver in the Mother Lode counties in 1922. Nearly all the ore mined in Amador County was treated in amalgamation mills, at most of which the ore is later concentrated. At the Argonaut the tailings are re-treated by cyanidation. In 1922 there was recovered as bullion 78,244.14 ounces of gold and 18,343 ounces of silver, and from concentrates and ore sent to the smelter a further recovery of 28,445.12 ounces of gold and 13,696 ounces of silver was made.

At Amador City the Bunker Hill mine was operated until November; the 40-stamp mill was stopped the last of November, after having crushed 43,000 tons of ore during the year. The Treasure

Mining Co. operated its mine until July and then closed indefinitely. A little placer gold was recovered by sluicing in the vicinity of Amador City.

At Camanche the No. 3 boat of the American Gold Dredging Co. was dismantled early in the year, and the final clean-up from this operation on Mokelumne River has been made. At Drytown a little gold was won by sluicing at the Garibaldi placer. At Ione some gold was produced at the Wicker hydraulic property and a small sluice. At Jackson the fire at the Argonaut mine in August closed both the Argonaut and Kennedy mines. During the first half of the year these mines had been running on good-grade ore, and their production was greater than in 1921. The plant formerly operated by the California Slimes Co., which treated tailings from the Argonaut mine, was sold to the Amador Metal Reduction Co. August 28, 1922. The Moore mine continued development, and a new 20-stamp amalgamation and concentration mill was installed on the property. Operations were also carried on at the Amador Queen No. 2 by lessees and at the Rich Gulch, French Hill, and Valparaiso pocket mines. At Oleta the Clark drift mine made a fair run, and the American Flat and Upton drift properties were under development. At Pine Grove the hydraulic mines of Cramner Bros. and Ludekens Bros. were producers. At Plymouth the 30-stamp mill of the Plymouth Consolidated Gold Mines Co. was operated throughout the year. This property is developed by a 3,450-foot shaft. A new ore shoot below the 3,400-foot level has been developed. At Sutter Creek a new steel head frame and electric hoist was installed at the Central Eureka mine, replacing old equipment. The 40-stamp mill was remodeled, and a considerable production made during the year. The Fremont mine was under development but had no production. At Volcano the Velvet deep mine was under development, and gold was produced at the Acosta drift and Elephant hydraulic mines.

### BUTTE COUNTY.

Two deep mines and 15 placer mines reported production from Butte County in 1922.

The placer production was 23,686.21 ounces of gold and 1,875 ounces of silver, valued at $491,512, as compared with $453,827 in 1921. Four dredges produced more than 92 per cent, 6 drift mines 7 per cent, and 5 surface mines less than 1 per cent of the total. The production from dredges and drift mines was greater than in 1921.

The pocket mines produced 7 tons of dry gold ore that carried 75.67 ounces of gold and 15 ounces of silver, valued at $1,579, in 1922, as compared with 81 tons of ore, which carried 223.01 ounces of gold and 82 ounces of silver, valued at $4,692, in 1921. All the gold and silver was recovered in the form of amalgam.

Near Chico the El Oro dredge operated all the year on Butte Creek, and some gold was saved at small drift properties tributary to Chico. Near Enterprise gold was saved at several surface placers, and the Gold Dust quartz mine was developed. At Feather Falls the Triumph quartz mine was developed, though no production was made. Near Forbestown some gold was saved by sluicing on the Garden and Geiger Meadows ranches. At Magalia the Highland Chief drift mine was developed. The Surcease mine, near Las Plumas, was developed

by the Gruss Mining Co., but no ore was produced. A little ore was taken from the Blue Ribbon pocket. Near Oroville the American Gold Dredging Co. operated one dredge and the Natomas Co. two dredges the entire year on American River. The boats operated by the Natomas Co. will probably go out of commission in 1923.[2] The Butterfly drift mine, in Morris Ravine, was productive, and some gold was produced at the Cherokee drift mine. About 5 miles above Oroville miners using diving apparatus recovered gold from the bed of American River, and considerable gold that came from small operations near Oroville was sold to local buyers. Near Paradise considerable gold was produced at the Lucky John drift mine, and development was pushed at the Wagstaff drift mine. At Stirling City some gold was produced at the Alder Creek placer.

## CALAVERAS COUNTY.

During 1922 there were 17 deep and 16 placer mines in operation in Calaveras County, as compared with 15 deep and 19 placer mines in 1921.

The production from placer mines was 9,400.71 ounces of gold and 678 ounces of silver, valued at $195,008, as compared with bullion valued at $187,083 produced in 1921. The Isabel dredge was the largest producer of placer gold in the county, and some gold taken from the final clean-up after dismantling the Camanche dredge, operated by the American Gold Dredging Co., should be credited to Calaveras County.

Calaveras County deep mines produced 206,485 tons of dry gold ore in 1922, from which 58,975.67 ounces of gold and 10,970 ounces of silver were recovered. The average value of the ore treated in 1922 was $5.96 a ton, as compared with $6.44 in 1921. The output of ore was about 1,600 tons greater than in 1921; the recovery of gold was 4,400 ounces less, but the recovery of silver was 1,400 ounces greater. All the ore mined in Calaveras County was first treated by amalgamation. At five mills concentrates were made amounting to 5,597 tons, which carried 14,657.17 ounces of gold and 4,366 ounces of silver. At two mills in Calaveras County the tailings were reground and cyanided. The total recovery of gold and silver in the form of amalgam and cyanide precipitates was 44,318.50 ounces of gold and 6,604 ounces of silver.

Near Altaville, on the ranch of the Victor Land & Cattle Co., drift mining resulted in saving considerable bullion in 1922. The Triple Lode gold mine, at Angels Camp, was opened during the year, and a 20-stamp mill was purchased, as development at a depth of 500 feet had disclosed some good ore bodies. None of the larger mines were in operation, but some gold was recovered by pocket hunters and small placer operators in the district. The dredge on Mokelumne River near Camanche, operated by the American Gold Dredging Co., was dismantled and gold recovered in the final clean-up. Local storekeepers also purchased some bullion won by small operations in the vicinity. The Calaveras Copper Co. at Copperopolis was engaged in development work throughout the year, with a view to early resumption of production. At Felix the Gold Knoll mine was operated

[2] Natomas Co. of California Ann. Rept. for year ending Dec. 31, 1922.

for a short time and bullion was produced at the 40-stamp mill. The Royal mine was the largest producer in the district. The Borden dredge, at Jenny Lind, was the largest producer of placer gold in the county. The dredge was operated throughout the year, part of the time on tailings. At Carson Hill the Carson Hill Gold Mines Co. took over the Melones mine, which was operated in conjunction with the Carson Hill and Morgan properties. This company made the largest production of gold in the county. The ore was treated in a 30-stamp amalgamation mill, followed by concentration, and the tailings after being reground were handled by the Melones Cyaniding Co. The Morning Star mine, at Mokelumne Hill, was given a thorough test. The 200-ton flotation mill was rebuilt, with the idea of concentrating and cyaniding both concentrates and tailings. Work was discontinued in December. At Mountain Ranch small pockets were opened on the Manitou and New Luxor claims. The Rigney hydraulic mine, at the head of Salamander Gulch, was worked for a short season and a good production made. Bullion was produced at the 30-ton stamp mill of the Tanner mine at Murphy. The Comet mine, at Railroad Flat, was under development by lessees, and bullion was produced in the course of development work on the Good Luck and Kinwodin mines. Several drift mines near San Andreas were under development, but the most important work in this section was at the Apex or Ford mine, where some good ore is said to have been shown by development. At Sheep Ranch the mill at the Washington mine was enlarged and a good production made. The Montacali Mines Syndicate produced some bullion before abandoning its option in June. Near West Point the Columbus, Keltz, and Lone Star mines were productive, and considerable gold was received by local buyers from several small operators in this district.

### COLUSA COUNTY.

The Clyde gold mine, in the Sulphur Creek district, near Wilbur Springs, was the only producer in Colusa County.

### DEL NORTE COUNTY.

The Myrtle Creek placer mine, near Crescent City, was the only producing property in Del Norte County, though development work was under way at the Blue Gravel mine.

### ELDORADO COUNTY.

There were 12 deep and 12 placer mines in operation in Eldorado County in 1922, as compared with 20 deep mines and 9 placers in 1921.

The 4 drift and 8 surface placers in operation produced 1,211.95 ounces of gold and 193 ounces of silver, having a value of $25,246. The drift mines produced 66 per cent and the surface placers 34 per cent of the gold. In 1921 the placers of Eldorado County produced bullion having a value of $5,615.

At the deep mines of Eldorado County 2,160 tons of dry gold ore was produced in 1922, as compared with 4,354 tons in 1921; the falling off was due largely to the discontinuance of production by the Grit Gold mine, at Greenwood. All the ore mined in Eldorado County was treated by amalgamation mills, and no concentrates

were saved. The bullion recovered carried 1,078.15 ounces of gold and 183 ounces of silver, as compared with 1,381.06 ounces of gold and 246 ounces of silver produced by the deep mines in 1921.

At Butcher Ranch the Hines-Gilbert mine was worked by lessees, who milled high-grade ore at the 10-stamp mill on the property. The Red Wing mine, near El Dorado, was operated, and gold was produced from several small pockets found in the vicinity. Near Garden Valley the Frog Pond mine was in operation. The Kenny quartz mine and the Pacific and Georgia Slide placers, near Georgetown, were worked, and local buyers purchased considerable gold from small placer operators. Near Greenwood the Golden Cup and Brainard pockets yielded considerable gold and a little gold was won by sluicing. The Grit Gold mine did not produce but was being developed. Some small sluicing operations near Latrobe resulted in the recovery of a little bullion. At Mount Pleasant the Humbug group was developed. Near Kelsey two pockets were opened. At Nashville work on the Havilla dump was discontinued in July. Considerable gold came into Placerville from small pocket and surface mines in the vicinity, but no large operations were conducted in this district. At Rescue a pocket was opened and some placer gold was taken in by local buyers.

### FRESNO COUNTY.

In 1922 there were 3 deep and 4 placer mines in operation in Fresno County, as compared with 3 deep mines and 2 placers in 1921.

The largest production was made by the Grant Rock & Gravel Co. at Friant, where the gold was saved as a by-product in the washing of gravel for road metal and building operations. A little gold was also won by surface placer mines near North Fork, Schilling, and Clovis.

The 3 deep mines were all small producers, yielding a total of 73 tons of siliceous gold ore, from which 27.11 ounces of gold and 2 ounces of silver was recovered by amalgamation. The largest operations were at the Dixie Queen mine, on Mill Creek near Dunlap, and the Sunnyside mine, on Hughes Creek near Del Piedra.

### HUMBOLDT COUNTY.

Six placer mines reported production of gold from mines near Orick, Eureka, Orleans, and Weitchpec in 1922. The total output was 64.33 ounces of gold and 10 ounces of silver, having a total value of $1,340, of which 87 per cent was recovered by hydraulic operations near Weitchpec. In 1921 the gold and silver produced from Humboldt County mines was valued at $2,091, all of which came from placer operations.

### IMPERIAL COUNTY.

Three deep mines and one placer were reported in operation in Imperial County in 1922. All the placer gold, 11.74 ounces, came from the Potholes district, north of Yuma. The cyanide plant at the Champion (old Paymaster) mine was operated by lessees until November and by the owner until December on silver-bearing ore. A shipment of lead ore carrying considerable silver was made from the

Winn mine, in the Potholes district, and a small shipment of dry gold ore from the Rabe mine, near Niland. There was 7,531 tons of material shipped or treated, which carried 5.23 ounces of gold, 18,021 ounces of silver, and 13,315 pounds of lead, having a total value of $18,861. The total value of deep and placer output from this county in 1921 was $1,457.

## INYO COUNTY.

In Inyo County 19 deep mines produced 34,670 tons of ore, having a total value of $698,736, as compared with 12,344 tons of ore, with a total value of $218,938, produced by 22 deep mines in 1921. The great increase was due to the revival of lead mining. In 1922 there was produced 26,374 tons of lead ore mined at 12 properties, 8,190 tons of dry gold ore mined at 4 properties, 104 tons of zinc ore, and 2 tons of dry silver ore. The ore mined in 1921 was classified as 2,626 tons of lead ore, 9,651 tons of dry gold ore, and 67 tons of dry silver ore. The metals recovered from ore mined in 1922 were gold 4,124.68 ounces, silver 256,009 ounces, copper 68,582 pounds, lead 6,270,121 pounds, and zinc 58,700 pounds. This is an increase of 236.64 ounces of gold, 169,989 ounces of silver, 26,349 pounds of copper, 5,223,512 pounds of lead, and 58,700 pounds of zinc over the production from Inyo County in 1921.

The greater part of the gold ore was concentrated, and the concentrates were shipped to a smelter, but 1,525 tons was treated in amalgamation mills, which recovered 655.03 ounces of gold and 188 ounces of silver in bullion. The bulk of the ore concentrated was lead ore carrying silver. The total quantity of ore concentrated was 21,884 tons, from which were made 1,705 tons of concentrates that carried 2,116.24 ounces of gold, 99,434 ounces of silver, 22,781 pounds of copper, and 1,050,230 pounds of lead. Of the 11,261 tons of ore sent directly to the smelter 11,155 tons was lead ore, 104 tons zinc ore that carried no other metals, and 2 tons dry silver ore. The recovery of metals from smelting ore was 1,353.41 ounces of gold, 156,387 ounces of silver, 45,801 pounds of copper, 5,219,891 pounds of lead, and 58,700 pounds of zinc.

No production was made at the Bunker Hill or Cometti mines, near Big Pine, but development work was under way at both properties. Near Bishop the Wilshire mine was under development and diamond drilling was done to prospect the deposit at depth. The 100-ton flotation mill was not in operation, but concentrates produced during the previous year were shipped. The Bishop Community Gold Producers operated the Casa Diablo mine and made a small production. At Cerro Gordo, near Keeler, silver-lead ore was mined from the surface at the Estelle mine. A considerable quantity of ore and concentrates was produced at the Cerro Gordo mine. The Santa Rosa mine was operated on a small scale until June. At Darwin lessees operated the Lucky Jim and Defiance mines of the Darwin Silver Co. and made a large production. A tram was built from the Defiance mine to the 50-ton mill, which was remodeled to include flotation equipment. Small shipments of lead ore were made from the Blue Bell and Hunt mines, and a final shipment of zinc ore from the Towser mine, formerly operated by the Utacala Exploration Co., was smelted. A small shipment of dry

gold ore was made from mines near Fish Springs. Lead ore was produced at the Valley View mine, in the Lee district, and shipped from Beatty, Nev. Near Lone Pine the Carbonate and Mount Whitney mines were the only active properties. Crude lead ore was shipped from the Tecopa mines, at Tecopa. The 50-ton mill was not operated during 1922. Mines tributary to Trona that were productive in 1922 were the Slate Range lead mine and the Stockwell gold mine. The Tango and Paddy Pride mines, near Zabriskie, were also productive, and operators shipped lead ore carrying silver and copper.

### KERN COUNTY.

In Kern County there were 22 deep and 4 placer mines in operation, as compared with 24 deep mines and 3 placers in 1921.

The production from placer mines was 137.92 ounces of gold and 53 ounces of silver, valued at $2,904, most of which came from dry-washing operations near Randsburg. A little placer gold was recovered by sluicing near Caliente and Isabella. In 1921 the placer production was valued at $1,278, practically all of it from the Randsburg district.

The production at deep mines was 12,248 tons of ore, carrying 5,876.89 ounces of gold and 6,471 ounces of silver, valued at $127,957, as compared with 11,559 tons of ore, carrying 4,036.26 ounces of gold and 1,880 ounces of silver, valued at $85,317, in 1921. The principal increase was that due to the revival of gold mining in the Randsburg district. All the ore mined in Kern County in 1922 was dry, and most of it was dry gold ore. The ore was all treated in gold mills, and no concentrates were shipped, all the gold and silver being recovered in the form of bullion and cyanide precipitates. Three mills using the cyanidation method were operated in the county.

A small quantity of siliceous gold-silver ore was produced at the Zenda and Josephine mines, in the Amalie district, near Caliente. At Bodfish the Way, Glen Olive, and Gwynne mines produced a few tons of dry gold ore that was milled locally. The Jeannette mine, near Piute, in the Green Mountain district, is worked each summer by the owner, who mills the dry gold ore locally. At Isabella the Keyes, Mammoth, Pennsylvania, and Potato Patch mines were worked on a small scale, and the ore was milled at the Keyes amalgamation mill and in arrastres. At Mojave the Standard Gold Mining Co. took over the properties of the Desert Treasure Co., and the Elephant United Co. took over the mines formerly worked by the Elko Gold Mining Co. A small production was made by the Standard Co. by cyaniding old tailings, and a little ore was produced by the Elko Co. before its properties went into the hands of the present owners. At Randsburg a number of lessees were at work in various places on the upper levels of the Yellow Aster and produced considerable ore that was treated at the Yellow Aster mill. The Black Hawk mine was worked by the Pittsburg-Mount Shasta Gold Mining & Milling Co. Above the 300-foot level a number of segments of the much faulted gold vein were mined. The King Solomon mine was bought by the North Rand Silver Mining Co., and development was continued, which resulted in the production of some siliceous gold ore. Smaller producers in this district were the Baltic, Butte

Consolidated, Sidney, and Renner mines. The Tropico mine, near Rosamond, is one of the larger producers of the county. It is developed by a 550-foot inclined shaft, with 5,000 feet of drifts on five levels. The ore is reduced in a 10-stamp 30-ton cyanidation plant. The Blue Mountain gold mine, near Woody, was under development throughout the year, and bullion and concentrates were produced from siliceous gold ore milled in 10 stamps on the property.

### LASSEN COUNTY.

The Juniper mine, at Hayden Hill, was worked part of the year, and bullion was recovered at the 10-stamp amalgamation mill. A little prospecting was under way at adjoining properties.

### LOS ANGELES COUNTY.

At Neenach the ball-mill amalgamation plant at the Big Chief mine was run until April.

### MADERA COUNTY.

In 1922 there were 4 deep mines and 3 placers in operation in Madera County, as compared with 3 deep and 2 placer mines in 1921.

The placer mines produced 29.70 ounces of gold and 11 ounces of silver, valued at $625, as compared with a recovery of $636 from placer mines the previous year. All the gold saved at placers was won by sluicing, and the greater part came from streams near O'Neals, Northfork, and Coarsegold.

The four deep mines produced 107 tons of ore, which carried 47.42 ounces of gold and 3,489 ounces of silver. The dry gold ore produced was 85 tons, from which 47.42 ounces of gold and 38 ounces of silver were saved by amalgamation; and 22 tons of dry silver ore shipped to smelters carried 3,451 ounces of silver.

The deep mines that were operated in 1922 were the Texas Flat, at Coarsegold; the Stayton, at Knowles; the Jesse Bell, at Daulton; and a small pocket opened near O'Neals.

### MARIPOSA COUNTY.

There were 17 deep mines and 7 placers in operation in Mariposa County in 1922, as compared with 12 deep and 7 placer mines in 1921.

The output of the placers, all of which was won by sluicing, was 204.32 ounces of gold and 44 ounces of silver, as compared with 354.93 ounces of gold and 80 ounces of silver in 1921. The largest placer output came from the vicinity of Bagby and Mariposa, but placer gold was also recovered near Coulterville, Hornitos, Mount Bullion, and Usona.

The 17 deep mines produced 15,532 tons of dry gold ore, which carried 10,369.05 ounces of gold and 3,257 ounces of silver, valued at $217,604, or $14.01 a ton, as compared with 30,577 tons of ore produced in 1921, which carried 15,671.47 ounces of gold and 5,171 ounces of silver. The great decrease is due to the closing of the Mountain King mine in January and the Virginia Belmont in October.

Near Bagby the Croesus and Jumper pocket mines were worked in a small way by the owners, and a little placer gold was bought and

reported by storekeepers. The Original mine, at Clearinghouse, was in operation throughout the year and produced bullion and concentrates at the 10-stamp mill on the property. Near Cathay the Moore Hill mine was being opened by the B. V. D. Mining Co., which was planning the installation of a 50-ton cyanide mill, and the Luckett mine by the Bobby Mining Co. The Virginia Belmont Mining Co. operated the Virginia mine, near Coulterville, for 10 months and produced bullion and concentrates. Gold was also produced from the Runover, McKee, Cuneo, Noce-Hart, and McLean pocket mines, near this place. Near Hornitos gold was produced at the Washington and Idaho mines and from small pockets. The Mountain King mine, at Mountain King, was closed early in January, but a final clean-up of the mill resulted in the shipment of bullion and concentrates. A small pocket on the Cattown mines yielded a little bullion. Several groups of mines formerly owned by the Mariposa Grant Co. have been sold to Kelso & Holmes, who are reopening the Mount Bullion and Mount Ophir mines.

### MERCED COUNTY.

There was a very small production of gold from a placer operation near Snelling and a deep mine near Merced Falls in 1922.

### MONO COUNTY.

Eight deep mines were operated in Mono County in 1922, as compared with 10 in 1921, and the total production of ore was 1,598 tons, as compared with 2,721 tons the previous year. The ore mined in 1922 carried 3,180.50 ounces of gold, 11,686 ounces of silver, 3,976 pounds of copper, and 9,774 pounds of lead, having a total value of $78,507. This is a decrease of 16,459 pounds of lead and 3,474 ounces of silver, but an increase of 1,354.15 ounces of gold and 1,781 pounds of copper, as compared with the production in 1921. Practically all the ore mined in 1922 was dry gold ore, only 47 tons of lead ore being shipped from the vicinity of Benton.

At Bodie a few lessees were at work in the Standard mine, but the production was not large, and the mill ran spasmodically. Siliceous gold ore was shipped by the Diamond Peak Development Co., operating the Golden Gate mine, near Colville. At Masonic several sets of lessees were at work in different parts of the Masonic Mines Association properties, the principal work being on the Chemung. A cyanide plant was being built on this property by lessees. On Mill Creek, 10 miles from Mono Lake, a little gold ore was taken from the Parrett group of mines.

### NEVADA COUNTY.

During 1922 there were 15 deep mines and 11 placers operated in Nevada County, as compared with 22 deep mines and 10 placers in 1921. The total production of the county was 140,460.32 ounces of gold, 19,583 ounces of silver, 420 pounds of copper, and 1,981 pounds of lead, having a total value of $2,923,322, an increase of $319,254, as compared with 1921. More gold was produced by the deep mines of Nevada County than by either deep or placer mines of any other county in the State in 1922.

There were 4 hydraulic, 4 drift, and 3 surface placers operated, which produced 3,239. 85 ounces of gold and 269 ounces of silver, having a total value of $67,243, an increase of $26,658 as compared with 1921. The principal increase in placer production was from drift and hydraulic mines.

The 268,640 tons of dry gold ore mined yielded 137,220.47 ounces of gold, 19,314 ounces of silver, 420 pounds of copper, and 1,981 pounds of lead, having a total value of $2,856,079, or an average of $10.63 a ton. The average in 1921 was $12.84 a ton. Practically all the ore mined in 1922 was treated at amalgamation mills, which recovered bullion carrying 136,079.81 ounces of gold and 17,751 ounces of silver. There was also saved 164 tons of concentrates, which carried 1,120.51 ounces of gold, 1,512 ounces of silver, and all the copper and lead produced in the county. Six tons of dry gold ore, sent direct to the smelter, carried 20.15 ounces of gold and 51 ounces of silver.

In the Graniteville region development work was under way at the Eureka, Mammoth, and Spottswood mines, but no production was reported. In the Grass Valley district the largest producers were the Empire, North Star, and Idaho-Maryland mines, though considerable gold was recovered at the Bray, Julia Ross, Girton, Newton, and several smaller properties. At the Idaho-Maryland mine 7,431 tons of ore was treated at the 20-stamp amalgamation and concentration mill during the year. The shaft was sunk an additional 100 feet. At the North Star mine 115,600 tons of ore was treated at the 60-stamp mill, from which $9.41 a ton in gold and silver was recovered at an average cost of $8.136 a ton.[3] The annual report of the company states that 9,128 feet of development work was done during 1922, which opened up additional ore in known areas. The company paid a 2 per cent dividend in 1922, amounting to $50,000. The Newtown mine was operated spasmodically, and additional concentrating equipment was added to the 10-stamp mill. At the Julia Ross mine the tunnel was pushed to develop veins as well as a gravel channel. At the Brunswick mine a 300-horsepower electric hoist was installed, and bailing was started in October, with the intention of reaching the 600-foot level. Work was pushed at the Banner and Norambagua mines by the Banner Consolidated Mines (Inc.). At the Alcalde the shaft was retimbered, an air compressor installed, and the mill put in repair. Several hundred tons of ore was developed at the South Star mine. In the Nevada City region the St. Louis was operated at intervals, and a few hundred tons of ore was milled at the 10-stamp mill. A considerable quantity of bullion was sold to local buyers, who reported that it came from small operations in the immediate vicinity. The Quaker Hill drift mine was a large producer of gold, and the Liberty Hill hydraulic mine was in operation. The tunnel on the Alta Combination was driven to develop the gravel channel. At North Bloomfield a large amount of work was done at the Malakoff drift property and some gold was produced at the Lung and Cassano placers. The Omega hydraulic mine, at Washington, was tested, and in the course of this operation some gold was saved. At You Bet the You Bet and Bear hydraulic mines were productive.

[3] North Star Mines Co. Ann. Rept., 1922.

### ORANGE COUNTY.

The Blue Lights mine, in Silverado Canyon, near Anaheim, produced silver-bearing lead ore.

### PLACER COUNTY.

In Placer County 11 deep mines and 26 placer mines were operated in 1922. The production of the deep mines was 4,061 short tons of ore, which carried 2,256.36 ounces of gold and 510 ounces of silver. The placer mines produced 3,532.86 ounces of gold and 442 ounces of silver. The total mine production was valued at $120,625, as compared with $133,536 in 1921.

In 1922 there were 16 drift mines in operation, at which 58 per cent of the placer gold of the county was saved. Nine surface mines were worked and yielded 13 per cent of the placer gold, and one dredge near Applegate was in operation most of the year.

All the ore mined in Placer County was dry gold ore and was treated at gold mills, which produced bullion containing 2,223.38 ounces of gold and 499 ounces of silver. Only 5 tons of concentrates were made, which carried 32.98 ounces of gold and 11 ounces of silver.

The dredge that was operated on Illinois River near Applegate by the American Gold Dredging Co. was sold to C. A. Geisendorfer, of Colfax, in August, and continued operation under the new management. A little bullion was recovered when the mill at the Oro Fino mine was dismantled, and considerable placer gold was sold to buyers in Auburn. The Centennial mine was developed under lease. A little gold was recovered by pocket hunters and sluicing operators in the vicinity of Butcher Ranch. Near Foresthill three pockets were found, which yielded nearly 800 ounces of gold, and some gold was saved in development work on the Baltimore, Durfer, and Paragon drift mines. At Gold Run lessees of the Stewart drift mine saved a small quantity of gold. At Iowa Hill a little gold was produced in the course of drifting operations on the Bonanza. The Blue Channel drift mines were under development, and storekeepers bought considerable placer bullion. Bullion was also produced at the New Zealand pocket mine. Some gold was recovered from prospect work on the Daniel Webster and Double O deep mines, at Michigan Bluff. The Glenn drift mine is the largest producer of placer gold in the county, but gold was also won by lessees on the Bigelow, Dixie Queen, Gorman, Hardclimb, and Last Chance drift mines. A little placer gold was obtained from drift mines near Rocklin and Roseville. The largest deep mine in the county was the Pioneer mine, at Towle, which is developed by tunnels and has a 20-stamp amalgamation and concentration mill. The concentrates are cyanided.

### PLUMAS COUNTY.

In 1922 there were 7 deep mines and 22 placers in operation in Plumas County, as compared with 10 deep mines and 28 placers in 1921.

The production from placer mines was 3,922.56 ounces of gold and 490 ounces of silver, having a total value of $81,577, an increase of 2,124.75 ounces of gold and 313 ounces of silver, as compared with

1921. The 5 drift mines in the county produced 82 per cent, and the 4 hydraulic mines and 13 surface mines each about 9 per cent of the gold produced by placer mines. The largest producer of placer gold was the Feather Fork drift mine, near La Porte, but a fair production was made at the Little Grizzly, near Genesee; the Slate Creek hydraulic, near La Porte; and the Lucky S. placer, near Taylorsville.

There was 438,836 tons of ore mined in Plumas County, of which 434,961 tons was copper ore and 3,875 tons was siliceous gold ore. The metal content of this ore was 6,866.26 ounces of gold, 296,764 ounces of silver, and 20,677,771 pounds of copper, having a total value of $3,230,201. This is an increase of 84 per cent, as compared with 1921, and is attributable entirely to the greater production of the Engels and Walker copper mines.

Practically all the copper ore was concentrated, and the gold ore was treated at amalgamation mills without concentration. Bullion saved at gold mills in 1922 contained 1,378.20 ounces of gold and 186 ounces of silver. There were 39,167 tons of copper concentrates produced, which carried 5,207.64 ounces of gold, 285,283 ounces of silver, and 19,890,598 pounds of copper. The smelting ore yielded 280.42 ounces of gold, 11,295 ounces of silver, and 787,173 pounds of copper.

A small amount of gold was taken from the Santa Rosa placer, near Clio. At the 2-stamp mill of the Wonder mine, near Blairsden, a small amount of gold ore was milled. Near Crescent Mills a small amount of bullion was saved at the Silent Friend mine, but operations at the Green Mountain mine were discontinued. At Engelmine the Engels and Superior copper mines were actively worked throughout the year. The 1,400-ton flotation mill handled 362,959 tons of ore, from which 24,652 tons of concentrates were made and shipped. The gross value of gold, silver, and copper recovered was $2,116,055, and the net cost per pound of copper was 12.21 cents.[4] At the Engels mine the lower or No. 10 tunnel was driven 4,100 feet to cut the ore body 500 feet below the lowest levels previously opened. A total of 7,574 feet of drifting and 2,478 feet of diamond drilling was done, and 1,900 feet of raises were put through the ore body to develop the stopes. The ore reserves of the two mines are estimated at 2,952,766 tons, carrying 2 per cent or more copper.[5] Of this amount 418,521 tons is broken and 1,637,445 tons is blocked out. This estimate does not include any ore below the tenth level of the Engels mine, though the existence of ore has been demonstrated by drilling. The Lucky S. placer, between Engelmine and Taylorsville, was worked through the season by its new owners. The Little Grizzly Creek hydraulic mine, near Genesee, was in operation. A small quantity of placer gold was won by sluice operations in the vicinity of Greenville. The Jamison mine, at Johnsville, was worked by Sobrero & Co., under lease until October, when the property reverted to the Plumas-Eureka Annex Mining Co. A test run was made at the Plumas-Eureka during the course of development work, and some placer gold was saved from the streams in the vicinity. A large production of gold was made as a result of drift operations on the South Fork of Feather River 10 miles from La Porte, by

[4] Engels Copper Mining Co. Ninth Ann. Rept., for year ending Dec. 31, 1922, p. 6.
[5] Idem, p. 17.

the Feather Fork Gold Gravel Co. The Maxine drift mine and the La Plante and Slate Creek hydraulic mines, near La Porte, were also worked. Near Pilot Peak the Pilot Peak, Willow Creek, and New Hope drift mines were under development, and some gold was recovered. The Pioneer and Sunnyside drift mines, at Seneca, were productive, but no deep mines in this section were worked. The Iron Dyke mine, near Taylorsville, was reopened under lease and developed for a few months. A small amount of placer gold was sold to local storekeepers. At Twain gold was recovered from bars of the Middle Fork of Feather River. The Walker mine, 8 miles north of Spring Garden, was a large producer of copper ore. Part of the ore was treated in a 225-ton flotation mill and part sent direct to Utah smelters. A considerable body of chalcopyrite ore has been developed during the last two years of operation.

### SACRAMENTO COUNTY.

The gold and silver produced in Sacramento County came largely from the seven gold dredges operated by the Natomas Co. of California at Natoma, though some placer bullion was obtained by small sluice operations in the streams near Folsom. The placer bullion produced in 1922 contained 65,342.50 ounces of gold and 3,392 ounces of silver, valued at $1,354,141, a decrease of $341,775 as compared with 1921.

According to the annual report of the Natomas Co., the net operating profit for the year was $457,400, which was considerably larger than in 1921, owing to lower power and material costs and to improvement in the recovery from the ground worked. The No. 1 dredge at Natoma finished its profitable ground on September 13 and was dismantled. The company estimates that there remains to be dug in the Natoma field about 110,000,000 cubic yards of paying gravel, which would indicate a life of seven or eight years at the present rate of extraction.

### SAN BERNARDINO COUNTY.

There were 22 deep mines in operation in San Bernardino County in 1922, as compared with 30 deep mines and 3 placers in 1921. The production of the county was 64,381 tons of ore, containing 6,082.08 ounces of gold, 2,374,948 ounces of silver, 13,190 pounds of copper, and 12,320 pounds of lead, valued at $2,503,134. The value of metals produced by deep and placer mines in 1921 was $3,431,366. The production of all metals in 1922 was less than in 1921, but the chief loss was in silver, the output of which was 835,758 ounces less. Of the ore mined 92 per cent came from the silver mines at Randsburg, and this ore carried nearly 85 per cent of the gold and about 99 per cent of the silver produced in the county. The 64,381 tons of ore mined included 4,453 tons of dry gold ore, 59,839 tons of dry silver ore, 40 tons of lead ore, 48 tons of copper ore, and 1 ton of copper-lead ore.

Gold and silver mills handled 4,650 tons of ore and recovered 791.08 ounces of gold and 4,203 ounces of silver; most of the silver was recovered by two cyanide plants and the bulk of the gold at four amalgamation mills. Besides the ore, 300 tons of old tailings

were treated at cyanide mills, yielding 65.37 ounces of gold and 1,103 ounces of silver.

At the flotation mill of the California Rand silver mine 46,476 tons of ore was concentrated to 1,975 tons of concentrates, which carried 2,097 ounces of gold and 675,916 ounces of silver.

Smelters took 12,955 tons of ore from San Bernardino County in 1922, the great bulk of which was siliceous silver ore, and recovered 3,128.63 ounces of gold, 1,693,726 ounces of silver, 13,190 pounds of copper, and 12,320 pounds of lead.

A small production of gold was made by lessees on the St. Elmo mine, near Atolia, and at Camp Rochester, near Barstow. In the Dale Mountains considerable work was done at the Los Angeles and Brooklyn claims, though no ore was milled. A small amount of bullion was recovered in preliminary operations at the Minnehaha mine, near Camp Baldy, at which a 40-ton amalgamation and concentration mill was installed. Almost no work was done in the vicinity of Cima, but a little lead-copper ore was shipped to Utah smelters that was mined in the course of development work at the Dutch Silver and Sunshine mines. Near Daggett a few hundred tons of lead and silver ore was produced at the Oriental, Silver Bow, Silver King, and Sioux mines. Two small shipments of copper ore were made from the Stonewall and Kent properties, near Ivanpah. A car of dry gold ore from the newly opened Gateway mine, on the west side of Pilot Peak, 20 miles southeast of Randsburg, was smelted. This property was developed by the Keller-Kent interests, of Bakersfield. The Gold Mountain mine, at Pine Knot, was operated under lease by the Big Bear Mining Co., and 4,000 tons of dry gold ore was treated at the 100-stamp mill. The California Rand Silver (Inc.), operating the Uranium Group (Kelly mine), and the Randsburg Silver Mining Co., owners of the Coyote, made a large production of dry silver ores. Threatened litigation concerning ownership of the productive veins developed by the Coyote resulted in the closing of that property, after a large amount of development work had been done. The Uranium group was developed by a new vertical shaft 1,300 feet deep, which is connected with the workings of the original inclined shaft. This new shaft has a steel head frame and an electric hoist. The flotation mill was enlarged to a capacity of 400 tons, and experiments were carried out for the local smelting of concentrates. The company paid $1,100,800 in dividends during the year. Shafts were being sunk on all sides of the Kelly mine in 1922, and at one time as many as 45 hoists were in operation in the district. The chief exploratory work was at the Grady, Black Hawk Silver, Belcher Extension, Garford, Bray, and Bisbee shafts, south of the Kelly; the Ben Hur, Silver Bell, Silver Moon, Treasure Hill, Mizpah-Montana, and Mizpah-Nevada, west and northwest of the Kelly; the Foster, Fox Lease, Cleary Lease, Carrol Lease, and Uranium No. 6 shafts, north of the Kelly; and the Silver King and Big Four shafts, east of the Kelly. Many of these shafts are over 300 feet deep and several over 500 feet deep, with a considerable length of drifts at various levels. No commercial ore was developed at any of them during 1922. Some dry gold ore was mined in the Victorville district, and a little lead and copper ore was shipped from Zurick.

## SAN DIEGO COUNTY.

The Hubbard and North Hubbard mines, in the Julian district, were developed during 1922, and some ore was milled. A small shipment of high-grade gold ore was made from the Chase pocket, near El Cajon, and a little placer gold was saved by sluicing at Campo and in the Julian district.

## SHASTA COUNTY.

There were 18 placer and 18 deep mines in operation in Shasta County in 1922, which produced a total of 28,353 tons of ore, 19,012.99 ounces of gold, 26,901 ounces of silver, 1,733,424 pounds of copper, and 2,954,250 pounds of zinc, valued at $822,339. This shows an increase of 22,200 tons of ore, 6,063.92 ounces of gold, 21,320 ounces of silver, 1,633,591 pounds of copper, and 1,896,519 pounds of zinc, but a decrease of 14,500 pounds of lead, as compared with the production in 1921.

The placer mines of Shasta County produced 15,380.00 ounces of gold and 1,642 ounces of silver, valued at $319,575, an increase of 3,636.19 ounces of gold and 576 ounces of silver as compared with 1921. Four dredges were in operation, though none worked full time, and produced nearly 97 per cent of the gold won by placer mining; 13 surface placers saved 3 per cent, and 1 drift mine less than one-tenth of 1 per cent of the output. The largest producers of placer gold were the Gardella and American dredges, near Redding, and the Shasta dredge, at Cottonwood.

The production from deep mines was 3,632.99 ounces of gold, 25,259 ounces of silver, 1,733,424 pounds of copper, and 2,954,250 pounds of zinc, valued at $502,764, an increase of $406,916 as compared with 1921. Included in this total is a considerable production of gold, silver, and copper recovered from cinders and other residues made by one of the large copper companies.

Dry gold ores, of which 3,385 tons was mined in Shasta County, yielded 2,937.53 ounces of gold, 1,444 ounces of silver, and 162 pounds of copper, an increase of 232 tons of ore, 1,786.26 ounces of gold, and 554 ounces of silver as compared with 1921.

Copper ore and slag yielded 165.98 ounces of gold, 8,425 ounces of silver, and 1,119,780 pounds of copper. Zinc ore yielded 529.48 ounces of gold, 15,390 ounces of silver, 613,482 pounds of copper, and 2,954,250 pounds of zinc (recovered as zinc content of zinc oxide pigment). The total quantity of copper and zinc ore was 24,968 tons.

In 1922 there was 3,381 tons of dry gold ore treated at amalgamation mills, which recovered 2,725.39 ounces of gold and 675 ounces of silver in the bullion. Four tons of dry gold ore was smelted, which yielded 0.49 ounce of gold, 674 ounces of silver, and 162 pounds of copper. Dry gold concentrates were saved at 3 amalgamation mills and yielded 211.65 ounces of gold and 95 ounces of silver. All the metal recovered from copper and zinc ores was made by smelting.

At Bayles two small surface placers were in operation during the working season. The Independence quartz mine, at Castella, and a sluice mine were operated and made a small production. The Balaklala mine, at Coram, was leased March 1 to the U. S. Smelting, Refining & Mining Co., but no ore was produced. Near Cottonwood the

Shasta dredge was operated for 11 months, but a shutdown, due to low water, was necessary in September. At French Gulch the Sybil mine was worked under lease by Thompson & Gray, who made a considerable production. In the course of examination and development work gold was also produced at the Brown Bear, Evening Star, Gladstone, Milkmaid, and Washington mines. Work at the Gladstone was under way until June, when the lease was abandoned. Near Igo some work was done at the Chicago silver mine after October and at the Continental, which resulted in a shipment of siliceous ore. The Lost Channel drift mine also produced. The mines of the Mammoth Copper Co., at Kennett, remained unproductive. The Stauffer Chemical Co. bought the Summit group, presumably to augment its supply of pyritic ore for the manufacture of sulphuric acid. Keswick has been abandoned since the completion of the tram from the Hornet mine of the Mountain Copper Co. to the new station at Matheson. A considerable quantity of pyrite was shipped from this property to makers of sulphuric acid on San Francisco Bay. Gold, silver, and copper are recovered as by-products from these operations. At Old Diggings the Reid mine was reopened to supply siliceous ore for the Bully Hill smelter. The April Fool mine, near Ono, was under development, and a little siliceous gold ore was produced. Near Redding the Holton dredge of the American Gold Dredging Co. and two boats owned by Lawrence Gardella operated throughout the year. The Gardella boats made the largest quantity of gold recovered in the county. The Haskins and Jones ranches have recently been acquired to give additional life to this enterprise. A little gold was produced at two pocket mines and the Silver Leaf mine. The Gold Leaf is to be reopened. At Winthrop the Bully Hill smelter, operated as a zinc oxide plant by the Shasta Zinc & Copper Co., began operations in June and continued to produce throughout the year. Copper, gold, and silver were recovered in matte, which was treated at Tacoma. The production of zinc oxide was discontinued late in December, and the plant has not been in operation during the first half of 1923.

### SIERRA COUNTY.

There were 16 deep and 16 placer mines in operation in Sierra County in 1922, as compared with 15 placers and 15 deep mines in 1921. The bullion produced carried 84,813.08 ounces of gold and 14,484 ounces of silver, valued at $1,767,726, an increase of $1,150,223 as compared with 1921.

The production from placer mines was 1,769.59 ounces of gold and 161 ounces of silver, valued at $36,742, as compared with $21,079 in 1921. The 4 hydraulic mines produced 69 per cent of the placer bullion, 9 drift mines 30 per cent, and 3 surface placers 1 per cent. The largest producers of placer bullion were the hydraulic mines at Brandy City, Table Rock, and Mountain House and a drift mine at Goodyears Bar.

The production from deep mines was 56,755 tons of dry gold ore, which yielded 83,043.49 ounces of gold and 14,323 ounces of silver, having a total value of $1,730,984. This is an increase of $1,134,560 in value of ore produced as compared with 1921 and reflects the increased activity of the Alleghany district. All the ore mined was

treated at amalgamation mills, which recovered 82,343.47 ounces of gold and 14,136 ounces of silver as bullion. At 4 mills 63 tons of concentrates were saved and yielded 700.02 ounces of gold and 187 ounces of silver.

At Alleghany there was considerable activity. The Sixteen to One mine was the largest producer of gold, followed by the Tightner and Eldorado Extension. Very rich pockets are found in all the veins of this district, and much gold finds its way out of the camp without a record of its origin. At the Eldorado-Wisconsin mine, developed by a 1,700-foot tunnel, 150-foot inclined shaft, and 1,200 feet of drifts, several thousand tons of $15 ore was milled at the 20-stamp amalgamation and concentration plant, which was erected during the year. At the Ophir mine work was discontinued in February, but a small production was made prior to the shutdown. The Original 16 to 1 mine, which was worked the entire year, milled about 1,500 tons of ore a month and made a large recovery of bullion. A very rich pocket was struck during the summer. The Plumbago mine was reopened by Griffith & Ray, and a little bullion was produced late in the year. The 20-stamp mill at the Tightner was worked throughout the year, and 3,500 feet of development work was done in the mine. The main adit is 6,000 feet long, and the mine is opened 900 feet below that level. The Irelan, Contact, Oriental, and Rainbow mines were being developed. At Brandy City the Yuba Development Co. operated a hydraulic mine for five months as a test of the gravels. Near Downieville ore was produced at the Bessler and Ironsides deep mines, and some gold was recovered at the Wide Awake drift mine and by a number of small placer operators whose product was sold to local buyers. The Finney and Comet mines were under development. At Forest the Kate Hardy mine was in operation early in the year and produced considerable bullion. The Contact and North Fork mines were being reopened. The Wisconsin drift mine yielded a small output. The Kirkpatrick drift, at Goodyears Bar, made a fair run, as did the Depot Hill hydraulic mine, near Camptonville. The Four Hills mine, near Johnsville (Plumas County), yielded considerable bullion from the 20-stamp mill on the property. Development work was started late in the year at the Brush Creek and Ante-Up mines, at Mountain House. At Sierra City the Butte Saddle and Butte Timber deep mines and two surface placers were in operation. The Hilda drift mine and the Bigelow quartz property were under development. The Loftus Blue Lead hydraulic mine and the Table Rock and Pacific Gold drift mines, at Table Rock, near La Porte (Plumas County), were producers of placer gold.

### SISKIYOU COUNTY.

During 1922 there were 23 deep mines and 37 placer mines in operation in Siskiyou County, which produced 3,633.17 ounces of gold and 612 ounces of silver, valued at $75,717, an increase of $32,788 as compared with 1921.

The placer mines produced 1,562.93 ounces of gold and 278 ounces of silver, valued at $32,587, as compared with $36,464 in 1921. Of the placer gold output 22 hydraulic mines yielded 83 per cent, 3 drift mines 2 per cent, and 12 surface mines 15 per cent. The largest quantity of placer gold was produced in the vicinity of

Sawyers Bar, Cecilville, Forks of Salmon, Somesbar, and Walker, in the Salmon River country. Water was not plentiful at any of the placer camps.

The deep mines produced 2,500 tons of dry gold ore, which yielded 2,070.24 ounces of gold and 334 ounces of silver, valued at $43,130, as compared with 854 tons of dry gold ore mined at 18 properties in 1921, which yielded 309.65 ounces of gold and 64 ounces of silver, valued at $6,465. All the ore mined in 1922 was treated at amalgamation mills, which produced bullion carrying 1,967.40 ounces of gold and 315 ounces of silver. Sixteen tons of concentrates were saved, which carried 102.84 ounces of gold and 19 ounces of silver.

The Black Bear mine, at Black Bear, was a small producer. At Callahan ore was milled at the Chapman, Kangaroo, and Trail Creek mines, and a small output of placer gold was made by sluice operations at the Two-and-a-Half mine. Work at the Chapman was stopped in the middle of February. About 75 tons of ore was milled from the Wild Irishman, Ida May, and Carter pocket mines, near Cecilville, and placer gold was recovered from the Banner, Jefferson Consolidated, and Summerville hydraulic mines. Near Etna Mills a trial run was made by the Siskiyou Syndicate mill, and the Homestake mill was run a short time, resulting in the recovery of some bullion. A few ounces of placer gold was bought by storekeepers. Nearly 100 ounces of placer gold was purchased by storekeepers at Gilta and Forks of Salmon, and the Bonanza deep mine was under development. The Shumway hydraulic property was leased by San Francisco interests, and considerable preparatory work was done, but no gravel was washed. At Fort Jones the principal producer was the Hawkeye deep mine, which was tested in 1922. Other quartz properties, which produced gold, were the McKinley, Makegan, and Taylor, but the production from all was small. About 26 ounces of gold was recovered at the Humbug and New Hope hydraulic mines. The Kunze Flat hydraulic mine, at Hamburg, was the only producer in that district. At Happy Camp 149 ounces of gold was recovered at the Crompton, Davis Consolidated, and Huey Hill hydraulic mines and by a few small sluice operations. The Bulldog and Independence quartz mines were worked, and the Independence was the next to the largest deep-mine producer in Siskiyou County. At Hilts the Hungry Creek and Mayflower sluice mines were operated, and a little ore taken from the Iron Dyke pocket yielded some bullion. A few ounces of placer gold was obtained from hydraulic and sluice mines near Hornbrook and Oak Bar. The Golden Ball quartz mine, near Rollin, operated by Fred Gowing, was the largest producing mine in the county. Over 1,000 tons of high-grade dry ore was milled at the 5-stamp amalgamation and concentration mill on the property. The blanket vein is developed by a 1,400-foot tunnel. From 7 hydraulic mines and 1 drift placer operated near Sawyers Bar there was recovered 827.16 ounces of gold and 169 ounces of silver. The largest producer was the Burns, the next the Hickey Homestead, and the John Frank, Paddy Cronin, Multo in Parvo, and Gold Bank hydraulic mines all contributed to the output of the district. The Fire Bug and Hundred Dollar quartz mines were also productive. The Snowflake and Enterprise deep mines were being developed, but no ore was milled. Preparations for hydraulicking were made at the

Long Tom and Peterson mines. The Ten Eyck hydraulic, at Somesbar, and the Lang Brothers and Quinn hydraulic mines, at Walker, produced nearly 100 ounces of gold. Near Yreka the Hoboken, Lucky Strike, and Mount Vernon mines were the chief producing properties; a total of 485 tons of ore was milled, yielding about 371 ounces of gold and 81 ounces of silver. The Big Joe sluice and Blue Gravel drift mines were also in operation.

### STANISLAUS COUNTY.

All the output of Stanislaus County in 1922, amounting to 5,079.12 ounces of gold and 614 ounces of silver, was recovered from placer mines, and the great bulk of the output was from the 9 cubic foot La Grange dredge, which operated throughout the year. A little gold was recovered by sluice operations near La Grange and Knights Ferry.

### TRINITY COUNTY.

In Trinity County 8 deep mines and 31 placer mines were in operation in 1922, which produced 8,848.67 ounces of gold, 2,432 ounces of silver, and 42,122 pounds of copper, valued at $191,036, a decrease of $248,347 as compared with 1921.

There were 15 hydraulic mines, 5 dredges, and 11 surface placers operated, which yielded 8,130.36 ounces of gold and 844 ounces of silver, valued at $168,913, or 88 per cent of the value of all metals recovered in the county in 1922. The production from Trinity County placer mines in 1921 was 20,728.93 ounces of gold and 1,315 ounces of silver, valued at $429,820. The great decrease in production was due principally to the fact that the dredges were not in operation for considerable periods and produced less than a third as much gold as usual. Hydraulic mining was less productive because of scarcity of water.

Seven gold quartz mines produced 452 tons of dry gold ore, which carried 662.31 ounces of gold and 99 ounces of silver. The Island Mountain copper mine produced 1,191 tons of ore that carried 56 ounces of gold, 1,489 ounces of silver, and 42,122 pounds of copper. The total value of metals produced at the deep mines in 1922 was $22,123, as compared with a gold and silver production in 1921 valued at $9,563. All the dry gold ore was treated at amalgamation mills, at which no concentrates were saved, and the copper ore produced in the county was smelted.

At Big Bar a few ounces of gold was taken by sluicing operations, and preparations were made to hydraulic the Saylor Bar placer. At Carrville the largest producer was the Pacific Gold Dredging Co., whose dredge was operated under difficult digging conditions for five months. This dredge was dismantled late in 1922. Lessees on the Bonanza King tunnel milled a little ore late in the year, and the Strode mine was developed. About 25 ounces of gold was saved at the Golden Gate, Steve's Gulch, and Underground Treasure placers, on Coffee Creek, and a small output of dry gold ore was made by lessees at the Packer group of quartz mines. At the McAtee Bar hydraulic mine, near Denny, a good clean up was made after a run of six months, and some gold was saved at the Eagle Bird, Esselae, Log Cabin, and Virgin placers. The total production from the camp,

all from placer mines, was 236.62 ounces of gold and 31 ounces of silver. Nearly 100 ounces of gold was saved from hydraulic operations near Douglas City, but no deep mines were operated. At Hayfork a few tons of ore from the Black Bess mine and Coumbs pocket yielded a little gold, and several ounces of placer gold was bought by local buyers. The Rattlesnake hydraulic mine and King quartz mine, near Helena, were producers. The Island Mountain copper mine, at Island Mountain, was reopened in November, after four years of idleness, and shipped more than 1,100 tons of low-grade copper ore high in iron to the Tacoma smelter. At Junction City the Valdor Dredging Co. worked out its ground and suspended operations on March 23. The boat was dismantled and rebuilt by the Lewiston Gold Dredging Co. to operate on the Martin ranch, near Lewiston. About 300 ounces of gold was recovered at three hydraulic mines. Near Lewiston the 9 cubic foot dredge operated by the Trinity Dredging Co., which was the largest producer of gold in the county, was in operation most of the year. The new 7½ cubic foot Gardella dredge on the Paulson ranch began digging in October and made good headway. The Lewiston Dredging Co. launched its boat in October but did not begin digging before the end of the year. Considerable gold was saved at the Bablew hydraulic mine and at small mines on the gulches in the district. The Venicia quartz mine was developed, but no ore was milled. Near Minersville a considerable acreage of possible dredge ground was tested by the Gardella interests, and it was reported that options were taken on two ranches. A little gold was recovered by sluice operations on Stope Creek, and the Five Pines deep mine was operated for some months during the summer. The Nugget Bar placers (Inc.) constructed a 6-mile ditch for hydraulic operations on Italian Gulch. At Trinity Center the Estabrook dredge began operations in December, after a shutdown of over a year. Near Weaverville the Democrat Gulch, Poverty Flat, and Weaver Creek hydraulic mines were productive, though water was not plentiful, owing to damage to the old La Grange dams. A large quantity of gold was handled by stores and banks at Weaverville, whose origin is uncertain but which doubtless came from small placer operations in various parts of the county.

### TUOLUMNE COUNTY.

In Tuolumne County 8 placers and 34 deep mines were in operation in 1922, as compared with 5 placers and 26 deep mines in 1921. However, work at a number of the deep mines in 1922 consisted of small pocket operations. The total output of the mines in the county was 10,756.96 ounces of gold and 2,976 ounces of silver, valued at $225,342, an increase of 6,111.70 ounces of gold and 471 ounces of silver as compared with 1921. The increase in production is largely attributable to the increased production of the Belmont-Shawmut mine, at Shawmut.

At 4 drift and 4 surface placers 476.70 ounces of gold and 48 ounces of silver were produced, valued at $9,902; of this gold output the drift mines contributed 90 per cent and the surface placers 10 per cent. The largest placer production was made at the Springfield tunnel, at Columbia. The yield from placer mines in 1921 was 298.96 ounces of gold and 51 ounces of silver.

At the deep mines 50,927 tons of dry gold ore was produced, from which 10,280.26 ounces of gold and 2,928 ounces of silver was recovered, having a total value of $215,440, an increase of $123,140 as compared with 1921.

Ore treated at gold mills, a total of 5,753 tons, yielded 2,863.53 ounces of gold and 734 ounces of silver. Three tons of ore was sent direct to smelters and yielded 30.41 ounces of gold and 23 ounces of silver. Concentrates produced at gold mills, amounting to 3,762 tons, carried 7,386.32 ounces of gold and 2,171 ounces of silver. The greater part of the concentrates was cyanided.

At Big Oak Flat about 86 ounces of gold and 19 ounces of silver were taken out in the course of development work on the Arizona, Eureka, and Silken pocket mines, and a few ounces of gold was recovered by sluice operations. The Clio Vindicator mine, at Chinese Camp, lost its 10-stamp mill by fire in August but made a fair recovery of bullion before that time. It is reported that a 100-ton amalgamation and cyanidation plant will replace the old mill. Placer mines in the vicinity sold a few ounces of gold to storekeepers. At Columbia about 75 ounces of gold and 24 ounces of silver were recovered by pocket hunters. The Springfield tunnel reached the channel, for which driving had been in progress for some years. At Jamestown all the gold produced from quartz in 1922, 105 ounces, came from the operations of pocket hunters and small mines. The Rawhide and Pacific Coast groups remained idle. The Tonopah Mining Co. did considerable development work on the 600-foot level of the Crystalline and Alabama mines, which it worked under option, but it milled no ore. The Belmont-Shawmut mine, at Shawmut, was the largest producer of bullion in Tuolumne County. The company abandoned the flotation process and substituted concentrating equipment in the 350-ton mill. The concentrates were cyanided. At Sonora more than 1,500 ounces of gold and 250 ounces of silver were taken from various small pocket mines. The Golden Gate mine, owned by Andrew McCormick, was reopened and made the largest production in the camp. The Mexican mine was worked by lessees, and some bullion was obtained from a test run by lessees at the Red Lead mine. The Sierra Mining & Reduction Co. discontinued operations early in 1922. The Black Oaks mine, at Soulsbyville, was not in operation, though the mine was kept free from water. No regular mining was done near Stent, but a little bullion was saved by lessees on the Santa Ysabel and by pocket hunters. At Tuolumne the Grizzly and Dead Horse mines were developed by the Grizzly Mining Co., and some bullion was saved from mill tests. A 100-ton cyanide plant is on the property. The Chileno and adjoining properties were developed by the Nevada Wonder Mining Co., which held the mines under option. A small amount of bullion was saved from mill tests. The Patterson mine was operated until July and produced nearly 1,500 tons of dry gold ore. A 20-stamp concentration and cyanidation plant is on the property. Several hundred ounces of gold was saved by lessees on the Norwegian and by pocket hunters in various parts of the district. Considerable prospecting and development work was done by the Casa Madera Co. on the Eliza and adjoining claims, as a result of which a reduction plant was planned.

## YUBA COUNTY.

There were 18 placer mines in operation in Yuba County in 1922, as compared with 21 placers and 1 deep mine in 1921. The yield of the placer mines was 120,596.34 ounces of gold and 8,222 ounces of silver, valued at $2,501,170, a decrease of more than 90 per cent as compared with the total output in 1921, valued at $4,764,383. This great decrease was due to the very material decline of production from the dredges and particularly from the boats of the Yuba Consolidated Gold Fields at Hammonton.

There were 10 dredges operated in 1922. The Pacific Gold Dredging Co. operated one boat with 9 cubic foot buckets in Browns Valley for the whole year. The Yuba Consolidated Gold Fields operated five boats with 17 cubic foot buckets for the full year, two boats with 7½ cubic foot buckets for eight months, and one boat with 7½ cubic foot buckets for three months. Two of the large boats of this company equipped with double stackers were engaged in deepening and making two channels, each 500 feet wide, on Yuba River above Daguerre Point. The Marysville Dredging Co. operated one boat with 16 cubic foot buckets at Marigold, adjoining the Yuba Consolidated property.

At the Oregon Hill mine, above Bullards Bar, preparations were under way for hydraulic mining, and some gold was recovered. Near North San Juan the Blue Clay drift mine was operated. Near Smartsville the Schoolboy and Yuba River placers were operated by drifting, and some gold was recovered by sluicing at various small placers. A little placer gold was bought by storekeepers at Dobbins, Wheatland, and Woodleaf.

# GOLD, SILVER, COPPER, AND LEAD IN OREGON.

(MINES REPORT.)

By J. M. Hill.[1]

## PRODUCTION.

The total value of the gold, silver, copper, and lead produced in Oregon in 1922 was 12 per cent less than the value of the metal output in 1921. This loss was entirely in gold, for the production of the other metals increased materially, as shown in the table below.

The 44 deep mines reporting in 1922 produced 35 per cent of the gold and 98 per cent of the silver credited to the State, as compared with 46 per cent of the gold and 90 per cent of the silver produced by 23 deep mines in 1921.

The 126 placer mines operated in 1922 produced 65 per cent of the gold and 2 per cent of the silver output, as compared with the production of 54 per cent of the gold and 10 per cent of the silver saved by the 84 placer mines operating in 1921. In 1922 the production from four dredges was 78 per cent of the total placer output. The production by hydraulic mining decreased considerably because of the scarcity of water, but there was an increase in the output from surface placers, which could operate with less water.

*Mine production of gold, silver, copper, and lead in Oregon, 1918–1922.*

| Year. | Number of mines producing. | Ore. | Gold.[a] | Silver.[a] | Copper. | Lead. | Total value. |
|---|---|---|---|---|---|---|---|
| | | *Short tons.* | | *Fine ounces.* | *Pounds.* | *Pounds.* | |
| 1918 | 120 | 126,681 | $1,270,465 | 107,323 | 2,451,016 | 10,601 | $1,983,942 |
| 1919 | 78 | 96,173 | 977,845 | 111,121 | 2,214,815 | ..... | 1,514,255 |
| 1920 | 67 | 82,156 | 1,017,490 | 82,743 | 2,355,276 | ..... | 1,541,051 |
| 1921 | 107 | 40,333 | 882,034 | 42,120 | 174,300 | ..... | 946,639 |
| 1922 | 170 | 27,522 | 531,568 | 151,812 | 1,046,525 | 76,970 | 828,894 |

[a] Includes placer production.

*Placer production of gold and silver in Oregon, 1918–1922.*

| Year. | Dredge. | | Hydraulic and drift.[a] | | Surface. | | Total value. |
|---|---|---|---|---|---|---|---|
| | Gold. | Silver. | Gold. | Silver. | Gold. | Silver. | |
| | | *Fine ounces.* | | *Fine ounces.* | | *Fine ounces.* | |
| 1918 | $387,740 | 3,336 | $93,654 | 612 | $16,855 | 154 | $502,351 |
| 1919 | 296,750 | 2,934 | 76,337 | 683 | 7,564 | 53 | 384,761 |
| 1920 | 358,864 | 3,939 | 88,604 | 889 | 3,649 | 25 | 456,407 |
| 1921 | 381,960 | 3,617 | 88,312 | 577 | 8,461 | 97 | 483,024 |
| 1922 | 269,994 | 2,452 | 58,537 | 393 | 17,606 | 166 | 349,148 |

[a] Drift mining operations were very small in 1918, 1919, and 1922.

[1] Miss Helen M. Gaylord, of the U. S. Geological Survey, assisted in the preparation of this report.

## ORE.

In 1922 there was mined 27,522 tons of ore at the deep mines in Oregon, a decrease of about 32 per cent as compared with 1921. The decrease was entirely in dry gold ore, of which only 6,449 tons was mined in 1922, as compared with 37,935 tons in 1921. The quantity of copper ore mined in 1922 was about seven times that mined in 1921, and although in 1921 no silver ore was mined in Oregon, in 1922 nearly 4,000 tons was produced.

All the silver and copper ore produced in the State came from mines in Baker County. The dry gold ores came from mines in nine counties, as shown in the second table below.

*Ore and metals produced in Oregon in 1922.*

| Source of production. | Ore. | | Gold. | | Silver. | |
|---|---|---|---|---|---|---|
| | Short tons. | Per cent. | Fine ounces. | Per cent. | Fine ounces. | Per cent. |
| Dry gold ore | 6,449 | 23.43 | 6,189.97 | 24.07 | 15,250 | 10.05 |
| Dry silver ore | 3,956 | 14.37 | 8.76 | .03 | 119,146 | 78.48 |
| Copper ore | 17,117 | 62.20 | 2,771.51 | 10.78 | 14,405 | 9.49 |
| Total deep mines | 27,522 | 100 00 | 8,970.24 | 34.88 | 148,801 | 98.02 |
| Total placers | ..... | ..... | 16,744.36 | 65.12 | 3,011 | 1.98 |
| Total, deep and placers, 1922 | 27,522 | 100.00 | 25,714.60 | 100.00 | 151,812 | 100.00 |
| Total, deep and placers, 1921 | 40,333 | ..... | 42,668.39 | ..... | 42,120 | ..... |
| Increase or decrease, 1922 | −12,811 | ..... | −16,953.79 | ..... | +109,692 | ..... |

| Source of production. | Copper. | | Lead. | |
|---|---|---|---|---|
| | Pounds. | Per cent. | Pounds. | Per cent. |
| Dry gold ore | 10,749 | 1.03 | 1,276 | 1.66 |
| Dry silver ore | 23,587 | 2.25 | 75,694 | 98.34 |
| Copper ore | 1,012,189 | 96.72 | ..... | ..... |
| Total deep mines | 1,046,525 | 100.00 | 76,970 | 100.00 |
| Total deep mines, 1921 | 174,300 | ..... | ..... | ..... |
| Increase, 1922 | 872,225 | ..... | 76,970 | ..... |

*Content of dry gold ore sold or treated in Oregon in 1922.*

| County. | Ore. | Gold. | Silver. | Copper. | Lead. |
|---|---|---|---|---|---|
| | *Short tons.* | *Fine ounces.* | *Fine ounces.* | *Pounds.* | *Pounds.* |
| Baker | 3,277 | 3,634.20 | 6,883 | 5,420 | ..... |
| Coos | 2 | 5.89 | 2 | ..... | ..... |
| Crook | 91 | 141.00 | 1,524 | ..... | 1,276 |
| Curry | 5 | 292.69 | 30 | ..... | ..... |
| Douglas | 15 | 131.74 | 212 | 170 | ..... |
| Grant | 1,978 | 1,080.03 | 6,164 | 4,724 | ..... |
| Jackson | 43 | 186.83 | 44 | ..... | ..... |
| Josephine | 343 | 369.89 | 309 | 435 | ..... |
| Malheur | 695 | 347.70 | 82 | ..... | ..... |
| | 6,449 | 6,189.97 | 15,250 | 10,749 | 1,276 |

The dry gold ore mined in Oregon in 1922 contained 24 per cent of all the gold produced in the State and about 70 per cent of the gold derived from deep mining. Its silver content is relatively low, and the copper and lead content is almost negligible. The ore had an average value of $22.44 a ton.

The silver ore mined in Baker County carried almost no gold but contained about 2 per cent of the copper produced in the State. Ore of this type mined in 1922 averaged about $32 a ton in value, of which $30 was in silver and gold.

The copper ore produced in Oregon in 1922 had an average value of $12.17 a ton, of which $4.19 was in gold and silver. Ore of this class constituted 62 per cent of the total ore produced in the State and contained 11 per cent of the gold, 9 per cent of the silver, and 97 per cent of the copper produced.

*Value of ore mined and treated in Oregon in 1922.*

| Class. | Ore (short tons). | Total value. | | Average value per ton. | |
|---|---|---|---|---|---|
| | | In gold and silver. | In all metals. | In gold and silver. | In all metals. |
| Dry gold | 6,449 | $143,208 | $144,729 | $22.21 | $22.44 |
| Dry silver | 3,956 | 119,327 | 126,674 | 30.16 | 32.02 |
| Copper | 17,117 | 71,697 | 208,343 | 4.19 | 12.17 |
| | 27,522 | 334,232 | 479,746 | 12.14 | 17.43 |

## GOLD.

The mine production of gold in Oregon in 1922 was 25,714.60 ounces, valued at $531,568, a decrease of 16,953.79 ounces and of $350,466, as compared with 1921. Baker County still maintained its lead as a gold producer, though the production from this county was only a little more than half as large as in 1921. Grant County mines made a slightly greater gold yield than in 1921, but the mines in Josephine and Jackson counties fell off in gold production from $158,227 to $61,477.

The placer production of gold in 1922 was 16,744.36 ounces, valued at $346,137, and was nearly double the output of gold from the deep mines. The output of placer gold from Baker and Grant counties was 84.83 per cent of the total placer-gold output of the State, because of the operation of the dredges in those counties. The value of gold produced by dredges was 78 per cent of the value of all gold won by placer mining and about 51 per cent of the value of all the gold produced in the State.

*Gold and silver produced at placer mines in Oregon in 1922, by counties.*

| County. | Dredge. | | Hydraulic and drift. | | Surface. | | Total value. |
|---|---|---|---|---|---|---|---|
| | Gold. | Silver. | Gold. | Silver. | Gold. | Silver. | |
| | | *Fine ounces.* | | *Fine ounces.* | | *Fine ounces.* | |
| Baker | [a] $269,994 | [a] 2,452 | $10,613 | 94 | $6,701 | 86 | $192,237 |
| Coos | | | | | 395 | 2 | 397 |
| Curry | | | 591 | 3 | 2,050 | 8 | 2,652 |
| Douglas | | | 1,013 | 4 | 961 | 9 | 1,987 |
| Grant | (a) | (a) | 440 | 8 | 283 | 15 | 98,449 |
| Harney | | | | | 71 | 1 | 72 |
| Jackson | | | 17,158 | 96 | 4,521 | 37 | 21,812 |
| Josephine | | | 26,362 | 175 | 1,928 | 4 | 28,469 |
| Malheur | | | 1,652 | 10 | 696 | 4 | 2,362 |
| Union | | | 436 | 1 | | | 437 |
| Wheeler | | | 272 | 2 | | | 274 |
| | 269,994 | 2,452 | 58,537 | 393 | 17,606 | 166 | 349,148 |

[a] Dredge output in Baker and Grant counties combined to avoid disclosure of output of individual companies.

## SILVER.

There was 151,812 ounces of silver produced in Oregon in 1922, an increase of 260 per cent as compared with 1921. The greatest contributor to the silver production was the Bay Horse mine, in Baker County, although the resumption of the production of copper ores at the Iron Dyke helped to increase the silver output. Placer mines produced only 3,011 ounces of silver in 1922, practically all of which came from Baker and Grant counties.

## COPPER.

The output of copper in 1922 from Oregon mines was 1,046,525 pounds, valued at $141,281, an increase of 872,225 pounds and $118,796, as compared with 1921. Baker County produced 99 per cent of the copper mined in the State.

## LEAD.

Lead was recovered as a by-product from ores mined in Baker and Crook counties chiefly for their silver and gold content. The production in 1922 was 76,970 pounds, valued at $4,233. No lead was saved from Oregon ores in 1921.

## METALLURGICAL INDUSTRY.

*Metallurgical recovery of metals in Oregon in 1922.*

| Method of recovery. | Ore treated. | Metals recovered. | | | |
|---|---|---|---|---|---|
| | | Gold. | Silver. | Copper. | Lead. |
| | *Short tons.* | *Fine ounces.* | *Fine ounces.* | *Pounds.* | *Pounds.* |
| Amalgamation and cyanidation | 2,705 | 2,297.38 | 639 | | |
| Smelting: | | | | | |
| Crude ore | 6,279 | 1,515.80 | 127,692 | 222,900 | 76,970 |
| Concentrates | 4,231 | 5,157.06 | 20,470 | 823,625 | |
| | | 8,970.24 | 148,801 | 1,046,525 | 76,970 |

In 1922 there was 2,705 tons of ore produced in Oregon and treated in gold mills, from which was recovered 26 per cent of the gold and less than 1 per cent of the silver produced from deep mines in the State. Only one cyanide plant in the State reported operations, and the reports from amalgamation mills do not give data concerning the consumption of quicksilver.

Dry gold ore treated at mills equipped for concentration amounted to 3,468 tons, from which 661 tons of concentrates were produced that contained 2,898.25 ounces of gold, 10,232 ounces of silver, and 9,756 pounds of copper. All of this ore was produced in Baker and Grant counties. Fifteen thousand tons of copper ore produced in Baker County was concentrated into 3,570 tons of concentrates, which contained 2,258.81 ounces of gold, 10,238 ounces of silver, and 813,869 pounds of copper.

*Gold and silver produced at amalgamation and cyanidation mills in Oregon in 1922.*

| County. | Ore to gold and silver mills. | Gold in bullion. | Silver in bullion. | Ore to concentrating mills. |
|---|---|---|---|---|
| | *Short tons.* | *Fine ounces.* | *Fine ounces.* | *Short tons.* |
| Baker | 1,381 | 1,149.25 | 310 | 16,938 |
| Curry | 5 | 255.69 | 23 | ..... |
| Grant | 313 | 194.05 | 161 | 1,600 |
| Jackson | 41 | 183.50 | 40 | ..... |
| Josephine | 270 | 167.19 | 23 | ..... |
| Malheur | 695 | 347.70 | 82 | ..... |
| | 2,705 | 2,297.38 | 639 | 18,538 |

*Mine production of gold, silver, and copper from Oregon concentrates in 1922.*

| County. | Concentrates. | Gold. | Silver. | Copper. |
|---|---|---|---|---|
| | *Short tons.* | *Fine ounces.* | *Fine ounces.* | *Pounds.* |
| Baker | 4,092 | 4,641.06 | 16,416 | 818,901 |
| Curry | 1 | 37.00 | 7 | ..... |
| Grant | 138 | 479.00 | 4,047 | 4,724 |
| | 4,231 | 5,157.06 | 20,470 | 823,625 |

In 1922 there was 6,279 tons of ore shipped direct to smelters from Oregon mines. Of this amount only 276 tons was dry gold ore, which contained 994.34 ounces of gold, 4,379 ounces of silver, 993 pounds of copper, and 1,276 pounds of lead. The dry gold ore shipped to smelters came from 7 counties, but most of it was from mines in eastern Oregon.

Baker County mines produced 3,956 tons of dry silver ore, which was shipped direct to smelters; the recovery was 8.76 ounces of gold, 119,146 ounces of silver, 23,587 pounds of copper, and 75,694 pounds of lead.

The 2,047 tons of copper ore sent direct to smelters also came from Baker County and contained 512.70 ounces of gold, 4,167 ounces of silver, and 198,320 pounds of copper.

*Metals produced from Oregon crude ores shipped to smelters in 1922.*

| County. | Ore. | Gold. | Silver. | Copper. | Lead. |
|---|---|---|---|---|---|
| | *Short tons.* | *Fine ounces.* | *Fine ounces.* | *Pounds.* | *Pounds.* |
| Baker | 6,031 | 624.16 | 123,708 | 222,295 | 75,694 |
| Coos | 2 | 5.89 | 2 | ..... | ..... |
| Crook | 91 | 141.00 | 1,524 | ..... | 1,276 |
| Douglas | 15 | 131.74 | 212 | 170 | ..... |
| Grant | 65 | 406.98 | 1,956 | ..... | ..... |
| Jackson | 2 | 3.33 | 4 | ..... | ..... |
| Josephine | 73 | 202.70 | 286 | 435 | ..... |
| | 6,279 | 1,515.80 | 127,692 | 222,900 | 76,970 |

## MINING INDUSTRY.

The gold-mining industry in southwestern Oregon during 1922 was not in a healthy condition. Most of the deep mines that had been in operation in 1921 were either closed or being developed without producing. At the Boswell, the promising mine of 1921, work stopped before January, 1922. Development was under way at the Gold Ridge, Millionaire, Bonanza, Sylvanite, and a few other deep mines, but the production from these sources decreased about $60,000. The placers were also handicapped by the continuous dry weather. Water was available for only a few months at most of the hydraulic mines. The surface sluicing properties therefore increased their relative output of gold, as they could be worked with less water, but the placers of this section produced about $20,000 less than in 1921.

In eastern Oregon the conditions were quite different. The Bay Horse silver mine, after a year's campaign of development, was a producer, and the Homestead Iron Dyke resumed milling at nearly its former rate. The Cornucopia mine did not produce, but it was under active development and should be on a producing basis soon. In the Cracker Creek district, Baker County, the E. & E. mines were closed in March, and their future is still uncertain. In the Granite district, Grant County, two flotation mills were being built and active development was going on at several properties. The Rainbow mine, in Malheur County, was a producer, but its cyanide mill was destroyed by fire early in 1923. During the later part of 1922 there was more activity in the Blue Mountains, when definite announcement of the early resumption of smelting at Sumpter was made. The dredges near Sumpter, John Day, and Bridgeport were the largest producers of gold in the State, but those at Sumpter and John Day operated only about nine months of the year, and the boat at Bridgeport spasmodically for testing, so the dredge production was much curtailed.

*Mine production of gold, silver, copper, and lead in Oregon in 1922.*

| County. | Ore (short tons). | Quartz gold. | | Placer gold. | | Total gold. | | Deep silver. | |
|---|---|---|---|---|---|---|---|---|---|
| | | Fine ounces. | Value. | Fine ounces. | Value. | Fine ounces. | Value. | Fine ounces. | Value. |
| Baker | 24,350 | 6,414.47 | $132,599 | 9,195.55 | $190,089 | 15,610.02 | $322,688 | 140,434 | $140,434 |
| Coos | 2 | 5.89 | 122 | 19.10 | 395 | 24.99 | 517 | 2 | 2 |
| Curry | 5 | 292.69 | 6,050 | 127.75 | 2,641 | 420.44 | 8,691 | 30 | 30 |
| Douglas | 15 | 131.74 | 2,723 | 95.50 | 1,974 | 227.24 | 4,697 | 212 | 212 |
| Grant | 1,978 | 1,080.03 | 22,326 | 4,737.95 | 97,942 | 5,817.98 | 120,268 | 6,164 | 6,164 |
| Jackson | 43 | 186.83 | 3,862 | 1,048.70 | 21,679 | 1,235.53 | 25,541 | 44 | 44 |
| Josephine | 343 | 369.89 | 7,646 | 1,368.51 | 28,290 | 1,738.40 | 35,936 | 309 | 309 |
| Malheur | 695 | 347.70 | 7,188 | 113.59 | 2,348 | 461.29 | 9,536 | 82 | 82 |
| Other counties [a] | 91 | 141.00 | 2,915 | 37.71 | 779 | 178.71 | 3,694 | 1,524 | 1,524 |
| | 27,522 | 8,970.24 | 185,431 | 16,744.36 | 346,137 | 25,714.60 | 531,568 | 148,801 | 148,801 |

| County. | Placer silver. | | Total silver. | | Copper. | | Lead. | | Total value. |
|---|---|---|---|---|---|---|---|---|---|
| | Fine ounces. | Value. | Fine ounces. | Value. | Pounds. | Value. | Ponnds. | Value. | |
| Baker | 2,148 | $2,148 | 142,582 | $142,582 | 1,041,196 | $140,561 | 75,694 | $4,163 | $609,994 |
| Coos | 2 | 2 | 4 | 4 | | | | | 521 |
| Curry | 11 | 11 | 41 | 41 | | | | | 8,732 |
| Douglas | 13 | 13 | 225 | 225 | 170 | 23 | | | 4,945 |
| Grant | 507 | 507 | 6,671 | 6,671 | 4,724 | 638 | | | 127,577 |
| Jackson | 133 | 133 | 177 | 177 | | | | | 25,718 |
| Josephine | 179 | 179 | 488 | 488 | 435 | 59 | | | 36,483 |
| Malheur | 14 | 14 | 96 | 96 | | | | | 9,632 |
| Other counties [a] | 4 | 4 | 1,528 | 1,528 | | | 1,276 | 70 | 5,292 |
| | 3,011 | 3,011 | 151,812 | 151,812 | 1,046,525 | 141,281 | 76,970 | 4,233 | 828,894 |

[a] Crook, Harney, Union, and Wheeler.

## REVIEW BY COUNTIES.

### BAKER COUNTY.

The value of the gold, silver, copper, and lead produced in Baker County in 1922 was $609,994 (74 per cent of the value of all metals produced in the State), $57,465 less than the value of metals produced by Baker County mines in 1921. The decrease was due entirely to loss in the production of gold, which declined from $605,465 in 1921 to $322,688 in 1922. The value of the silver produced was more than $100,000 greater than in 1921; that of copper increased by nearly $120,000, and that of lead by more than $4,000.

There were 18 producing mines and 36 placer operations in Baker County during 1922, as compared with 10 deep mines and 12 placers in 1921. The value of the deep-mine production in Baker County in 1922 was $417,757, as compared with $363,631 in 1921. The quantity of gold produced by deep mines in 1922 (6,414.47 ounces) was only 43 per cent as great as in 1921. The ore produced in the county amounted to 24,350 tons, as compared with 38,569 tons in 1921, but the average value of the ore mined was $17.16, as compared with $9.43 a ton in 1921, an increase due largely to the high value of the silver ore produced at the Bay Horse mine. Of the total ore mined in 1922, 70 per cent was copper ore, 16 per cent silver ore, and the rest gold ore.

The gold ore mined averaged about $25.25 a ton, practically all of which was in gold and silver. The silver ores averaged a little over $30 a ton in gold and silver and $32 a ton in all metals, and the copper ore $4 in gold and silver and $12 in all metals.

The total quantity of dry gold ore mined in Baker County in 1922 was 3,277 tons, of which 28 tons was sent direct to the smelter, 1,381 tons was treated at amalgamation mills, and 1,868 tons was handled at mills where amalgamation was followed by concentration. A total of 522 tons of concentrates was made that contained 4.56 ounces of gold and 12 ounces of silver to the ton.

The siliceous silver ore was shipped direct to the smelter, as was about 2,000 tons of the copper ore mined. The greater part of the copper ore was concentrated by flotation (about 5 into 1), and the copper concentrates averaged 0.63 ounce of gold and 2.87 ounces of silver to the ton and 11 per cent copper.

Placer operations in Baker County resulted in the recovery of gold and silver to the value of $192,237, as compared with $303,828 in 1921. The dredge production declined $115,170, but surface placers produced about $5,000 more than in 1921, and hydraulic mines produced practically as much as in 1921. The decline in dredge production was due to the shortage of power late in the fall, which curtailed operations.

*Cable Cove district.*—The Imperial Eagle Mining Co. milled and shipped for testing ore from the Miner and Eagle veins, both of which have been extensively opened by tunnels. The Eagle vein was cut in the Miner tunnel at considerable depth below previous developments. The Baisley-Elkhorn was bonded to the Delaware Mining Co. in June, and since then considerable surface work has been done preparatory to a campaign of deeper development.

*Connor Creek district.*—The U. S. Metals Co., operating the Bay Horse silver mine, near Huntington, was a steady producer. Development work during the year demonstrated considerable ore reserves and a new body of ore lying west of a dike that was thought might be the wall. A tunnel to attain 400 feet more depth was being driven.

*Cornucopia district.*—The Cornucopia Mines Co., though not a producer in 1922, completed developments that should result in an early resumption of production. The 4,700-foot crosscut to the Last Chance vein on the Union tunnel level was completed, and a 1,260-foot raise to the lower workings on the Last Chance vein was broken through late in the year. In September fire destroyed the buildings and upper tram terminal at the Last Chance mine. The ore from the Last Chance vein will all be handled through the new connection and milled at the Union mill. It is reported that the Queen of the West vein has been picked up in the course of prospect work by the Gold Reef Mining Co. A small quantity of gold was produced by sluicing at the Golden Hand mine, on Pine Creek.

*Cracker Creek district.*—The Blue Mountain Mines Co., operating the E. & E. or Bourne mine, produced early in the year but ceased operations in March. The property then reverted to the Bourne Gold Mining Co., and since that time there has been little activity in the district. Production was reported from the operations of lessees at the Mammoth, Bowers, and Buckeye properties. The Sumpter and Powder River dredges were in operation through nine

months of the year, and a little gold was recovered by sluicing in the district.

*Greenhorn district.*—The Bonanza Consolidated Gold Mining Co. produced siliceous gold ore at the Bonanza mine, near Whitney, during 10 months of operation, and lessees made some small shipments of ore from the Intermountain mine to the Oregon Idaho Investment Co., of Baker. Several placer mines were operated in the district, most of the recovery being made by sluicing.

*Homestead district.*—The Iron Dyke mine began regular production in May, after a shutdown of over a year, and was the largest producer in the State. The 100-ton flotation mill started in June and continued in operation through the year, treating 15,000 tons of ore. Crude ore was shipped, as well as the concentrates, to Utah smelters. The Copper Trust Syndicate was developing ground near the Iron Dyke.

*Rye Valley district.*—A small amount of placer gold was won by various operations near Durkee and Rye Valley, but no production was made from quartz mines.

*Snake River district.*—A nominal output of gold was reported from placer operations on Snake River near Robinette and Home.

*Sparta district.*—The Macy property, near Sparta, which has been under development for a year, was the principal producing deep mine in the Sparta district. A small production was made by lessees of two other quartz properties, and a little gold was recovered by sluicing operations on Pine Creek.

*Stice district.*—The Whited quartz mine, near Unity, made a nominal production. Hydraulicking was under way at the Tom-Tom, Yellow Metal, Cow Creek, and Bulldog placers, on Pine Creek near Hereford, and considerable gold was sold to local buyers by various small operators near Bridgeport, Hereford, and Whitney. The Superior Dredging Co. used its old boat for testing its property near Bridgeport and is expected to install a larger dredge in the near future.

*Virtue district.*—The Virtue Mines Development Co. made a small production of gold from quartz treated in its 10-stamp mill.

*Weatherby district.*—The Dixie mine, operated by Rizor & Lovejoy, was under development, and a small production was made by the 5-stamp mill. A nominal placer production was made by sluicing operations on Chicken Creek, near Durkee, and at Dixie.

## COOS AND CURRY COUNTIES.

A prospect near Myrtle Point, in Coos County, yielded a small quantity of siliceous gold ore, and the Robert E. and Prince Albert mines, in the Chetco district of Curry County, produced high-grade siliceous gold ore that was obtained in prospect and development work. The deep-mine production from these two counties was 7 tons of ore, carrying 298.58 ounces of gold and 32 ounces of silver, having a total value of $6,204.

Four beach miners in the vicinity of Bullards and Powers, Coos County, sluiced 19.10 ounces of gold and 2 ounces of silver. In Curry County the largest placer production was obtained from hydraulic and sluice operations in the vicinity of Sixes. The Elkhorn placer, in the Elk River district, was worked by drift, and

some gold was recovered by sluicing at Illahe and by beach mining at Sixes, Port Orford, and Wedderburn. There were 12 placer operations in Curry County, as compared with 6 in 1921, and the placer production was 127.75 ounces of gold and 11 ounces of silver, as compared with 26.90 ounces of gold and 9 ounces of silver in 1921.

### DOUGLAS COUNTY.

A small shipment of high-grade siliceous gold ore was made from the Continental mine, 12 miles from Myrtle Creek. It was reported that a ledge of good ore was being opened on South Umpqua River 14 miles above Tiller by Clark & Tainer, of Canyonville.

A small quantity of gold and silver was saved by 3 sluice miners in the Bohemia district. The Victory drift mine, near Koler, was operated, and the Gopher, Golden Bell, and Picune hydraulic mines, in the vicinity of Days Creek, were operated part of the year, but water was very scarce. The total placer production of Douglas County was 95.50 ounces of gold and 13 ounces of silver, as compared with 148.95 ounces of gold and 29 ounces of silver in 1921.

### GRANT COUNTY.

In Grant County 9 deep mines were in operation in 1922, as compared with 2 in 1921, and about 900 tons more of siliceous gold ore was produced than in the previous year. The total production from deep mines in 1922 was 1,978 tons of siliceous ore, which had a total value of $29,128, or approximately $14.73 a ton. Ore sent to amalgamation mills amounted to 313 tons and averaged $13.33 a ton in gold and silver. There was 1,600 tons of $9 ore concentrated to 138 tons, which yielded $105.77 a ton at the smelter. There was also shipped to smelters 65 tons of crude ore that averaged $160 a ton.

*Cable Cove district.*—The Mormon Boy group was under development by lessees, who expected to continue production in 1923.

*Canyon City district.*—The Mother Lode mine, near Canyon City, continued production. No other mines in this vicinity reported operations.

*Granite district.*—The Independence mine, operated by the United Gold Mining Co., was the largest producer in the Granite district, though the mine was operated only four months. Additions were made to the flotation mill, increasing it to 50-ton capacity. The Beaver Gold Mining Co., operating the Buffalo Monitor mine under lease, produced some shipping ore in the course of development work up to July; the rest of the year was devoted to the erection of a 30-ton flotation mill, which was completed in March, 1923. The Pot Latch, Continental, and Blue Ribbon mines also produced some ore. A 60-ton cyanide plant was under construction at the La Bellevue mine, and exploration work was carried on, but no ore was milled. The mill at the Magnolia mine was overhauled, ready for production in 1923. There was a small production of placer gold from hydraulicking and sluicing in the Granite district, and the Wild Cat hydraulic mine, on Clear Creek, enlarged its ditch and installed an elevator preparatory for work early in 1923.

*Greenhorn district.*—There was very little activity in the Greenhorn district, only one hydraulic mine reporting any output. The Royal White quartz mine was expecting to operate in 1923.

*John Day district.*—The Empire dredge, at John Day, operated for nine months and was the largest producer in Grant County.

*Quartzburg district.*—Some development work was under way at the Equity and Ophir groups, in the Quartzburg district, not far from Prairie City, but no ore was treated.

*Susanville district.*—The Rex and Big Badger quartz mines, on Elk Creek near Susanville, were productive. At the Rex mine a 5-foot Huntington mill was installed late in the year, and the Big Badger property has a 5-stamp amalgamation plant. The surface equipment at the Compton mine, burned in 1921, was repaired, the inclined shaft was unwatered, and development work on the 150-foot level was undertaken. At the Gem of the Mountain mine development was under way, but there was no production. A small quantity of placer gold was recovered by sluice miners in the Susanville district.

## JACKSON COUNTY.

In Jackson County 43 tons of siliceous gold ore, having an average value in gold and silver of $90.84, was produced in 1922, principally by the Skyline mine, near Ashland. Some of this ore was obtained from quartz pockets. The Afterthought mine, in the Applegate district, was under development, but no ore was produced. In the vicinity of Gold Hill several properties were being developed. The Gold Ridge, a producer in 1921, was taken over by the Modoc Exploration Co., of Gold Hill, which continued development work. Several hundred tons of low-grade ore has been developed at the Clausen mine, but no milling has been attempted. The Millionaire and Red Ribbon mines were under development during the later part of the year, but no ore was milled. At the Sylvanite mine the mill was rebuilt and several hundred feet of development work accomplished by the Oregon-Pittsburgh Mining Co. The Trust Buster claims, at Sams Valley, were further opened by tunnels, but no ore was produced.

There were 20 placer operations in Jackson County in 1922, as compared with 11 in 1921, but the placer production was small on account of scarcity of water in the working season. The total production of the placer mines in the county was 1,048.70 ounces of gold and 133 ounces of silver, valued at $21,812, of which approximately 79 per cent was from hydraulic mines. The Layton hydraulic mine, in Ferris Gulch, near Applegate, was the largest producer in the county and was operated for seven months by the Pacific Placer Co. Some small hydraulic operations near Ruch and Hilgard, in the Applegate district, also produced, and a little gold was won by sluicing in the vicinity of Applegate.

Three placer mines in the vicinity of Ashland were in operation. Near Gold Hill the Ancient River Gold Mining Co. was working with drag-line scraper and pumping the water for sluicing. Tailings from this operation are in demand for railroad gravel and road work. The Duffield-Burns hydraulic property, on Galls Creek, was worked in a small way, and a little production came from small hydraulic operations on Rogue River. The Demmer and Pearce hydraulic

mines, a short distance south of Jacksonville, were in operation, and sluicing at several localities resulted in a gold output of about 100 ounces from the vicinity of Jacksonville. The Stirling hydraulic mine, near Medford, which had water for four months in the spring, made a fair production. Considerable gold that came from small operations tributary to Medford was handled by local buyers.

### JOSEPHINE COUNTY.

The 35 properties in Josephine County produced gold, silver, and copper having a total value of $36,483, as compared with $126,388 in 1921. The output of placer mines decreased 40 per cent, and the quartz production more than $70,000, as compared with 1921. All the ore mined in 1922 at the quartz properties, 343 tons, was siliceous gold ore, carrying some silver and a small quantity of copper, which had a total value of $8,014. Of this ore 270 tons was treated by amalgamation mills at the mines and the rest was smelted. The ore treated by amalgamation produced 167.19 ounces of gold and 23 ounces of silver and had an average value of about $13 a ton. The 73 tons of ore sent direct to the smelter had an average value of about $62 a ton and carried 202.70 ounces of gold, 286 ounces of silver, and 435 pounds of copper.

Five deep mines were operated in Josephine County. The largest quartz mine was the Oregon Bonanza, 12 miles south of Grants Pass, which mined and shipped crude ore to Tacoma. In the course of development and prospect work on the Copper Queen mine, in the Graves Creek district, near Leland, some oxidized gold ore was shipped from surface workings. Copper ore was formerly produced at this mine, which has been closed for some years. The Western Metals Mines Co. is developing the Victor group of mines, near Galice. The January First mine, near Kerby, was operated by Harry Siskron, and a test run was made on ore from the Joker mine, near the same place. The Thompson group, in the Wolf Creek district, was under development, and a little gold was recovered from mill tests of ore. The Boswell mine, at Holland, was not operated.

There were 30 placer operations in Josephine County, 21 of which were hydraulic, 7 sluice, and 2 drift mines. The production from hydraulic mines was 93 per cent of the total placer output of the county.

In the Althouse district, near Holland, the Mint, Bullion, and May Queen hydraulic mines were the principal producers, though several small hydraulic mines worked by lessees shipped through storekeepers at Holland. The Lucky H and Olivia drift mines were also operated on a small scale. No detailed information is available concerning operations in the Applegate region, though considerable gold, presumably from hydraulic operations in this district, was received by buyers at Grants Pass. In the Graves Creek district the Browning and Red Point hydraulic mines had water for about four months, and a number of small hydraulic and sluice operators sold gold to local buyers at Placer and Grants Pass. In the Jumpoff Joe district the Swastika, Smith, Dean, and Rock Gulch hydraulic mines were the chief operators, but several sluice mines were in operation, and banks reported purchase of over 175 ounces of gold from small operators in the district. The Logan, Vass, and Anderson hydraulic mines, in

the Waldo district, were worked about four months early in 1922, and considerable gold that was sent out by individual lessees on various properties must be credited to hydraulic and sluice mines in this district. In the Wolf Creek district the Jason and Blue Channel hydraulic mines were worked for four months.

### MALHEUR COUNTY.

There were 3 deep mines and 5 placer mines in operation in the Mormon Basin and Rye Valley district, and a small amount of gold was recovered from Snake River near Ontario. The total production of Malheur County was valued at $9,632, of which the deep mines produced 75 per cent. The largest producer was the Rainbow Mining Co., at Rye Valley, which operated a 100-stamp mill and cyanide plant during most of the year. The plant was destroyed by fire early in 1923. The Sunday Hill mine was opened by a group of operators from La Grande, who built a 5-stamp amalgamation mill, at which a test run was made. A small amount of gold was shipped from a clean-up at the Red, White, and Blue mine.

The Jed Blair hydraulic property, on Basin Creek, was operated by John Boswell, and the Colt Bros. and Hansen hydraulic mines, near Malheur, were operated during the season. Several small surface placers at Malheur were worked, the gold going to local buyers, and a little gold was recovered by rocking along Snake River by skim-bar miners, who sold their gold to storekeepers at Ontario.

### OTHER COUNTIES.

Siliceous ore was shipped from a property near Prineville, Crook County, In Harney County a few ounces of gold was sluiced from a tributary of Trout Creek, 23 miles south of Silvies. A hydraulic mine near Hilgard, Union County, produced several ounces of gold, as did two hydraulic mines in the Spanish Gulch district, Wheeler County.

# GOLD, SILVER, COPPER, LEAD, AND ZINC IN MONTANA.

(MINES REPORT.)

By C. N. Gerry.[1]

## PRODUCTION.

### GENERAL FEATURES.

The value of the mine production of gold, silver, copper, lead, and zinc in Montana was nearly three times that of 1921, when many of the mines were idle most of the year. The output was below normal, however, as the average value for the last 10 years was nearly $75,000,000. Silver Bow County, which includes the Butte or Summit Valley district, continued to produce most of the silver, copper, lead, and zinc, but most of the gold was mined in other districts. Published dividends amounting to $145,099 were paid by the Butte & Superior Mining Co.

*Mine production of gold, silver, copper, lead, and zinc in Montana in 1921 and 1922.*

| Year. | Number of producers. | Ore. | Gold.[a] | Silver.[a] | Copper. | Lead. | Recoverable zinc. | Total value. |
|---|---|---|---|---|---|---|---|---|
| | | *Short tons.* | | *Fine ounces.* | *Pounds.* | *Pounds.* | *Pounds.* | |
| 1921 | 445 | 1,324,801 | $1,480,763 | 6,558,713 | 48,098,730 | 20,366,917 | 23,275,966 | $16,324,521 |
| 1922 | 393 | 4,385,878 | 1,656,757 | 12,468,151 | 165,754,442 | 29,767,479 | 119,069,818 | 44,925,949 |
| Increase or decrease, 1922 | −52 | +3,061,077 | +175,994 | +5,909,438 | +117,655,712 | +9,400,562 | +95,793,852 | +28,601,428 |

[a] Includes placer production.

### TREND OF MINING IN MONTANA.

The early history of mining in Montana, as in other Western States, deals principally with the production of placer gold, which began in 1863. Though important, this gradually gave place to silver mining, which began in a small way at Butte in 1865 and reached its climax in 1887. An effort to smelt copper ore was made at Butte as early as 1866, but production of this class of ore did not begin in earnest until after the advent of the railroad, in 1881. From that time until 1918 the production of silver and copper from the mines of

[1] Valuable assistance, especially in the compilation of the statistical tables of this report, was given by B. N. Patchell, of the United States Geological Survey.

Montana, especially in the Butte district, steadily increased. In 1887 the mines of Butte produced more copper than the Lake Superior region, and the record has been exceeded in 1907 and 1908 and since 1910 only by the mines of Arizona. From 1884 to 1898 the Anaconda Copper Mining Co. produced more than 1,000,000,000 pounds of copper. In 1883 Montana produced nearly 25,000,000 pounds of copper, and in 1916, the record year, nearly 353,000,000 pounds; since that time the output has decreased.

Montana has been a large producer of silver since 1885. Recently the largest output was that of 1918, when 16,797,479 ounces was produced, but old records show that the mines produced about 17,700,000 ounces in 1895. The gold output, valued at more than $2,000,000 in 1880, rose to more than $5,200,000 in 1887. It was $5,000,000 in 1915 but has since decreased.

The output of lead was large from 1891 to 1903, averaging about 21,000,000 pounds a year. The yearly production decreased from 1902 to 1911 but increased again from 1912 to the present time, when considerable lead is saved from lead-zinc ore. Zinc was produced in 1905, and the output has been large since 1910, both from ore smelted and from that treated locally in the electrolytic plant.

The following tables give the production of the State in the last 12 years and a separation by kinds of ore. The decrease in placer gold and gold in siliceous ore is notable, though the output of silver has been upheld. In normal times a large production of silver, lead, and zinc can be expected from lead ore, zinc ore, and lead-zinc ore, owing to recent improvements in the milling and leaching of these classes of ore. The output of gold, silver, and copper from copper ore has naturally been small since the World War, and the climax may have been reached in 1916, but there is every reason to expect a large production from the Butte district for many years.

*Mine production of gold, silver, copper, lead, and zinc in Montana, 1911–1922.*

| Year. | Ore. | Gold. | Silver. | Copper. | Lead. | Zinc. | Total value. |
|---|---|---|---|---|---|---|---|
| | *Short tons.* | *Fine ounces.* | *Fine ounces.* | *Pounds.* | *Pounds.* | *Pounds.* | |
| 1911 | 4,940,303 | 179,498.87 | 11,985,196 | 272,847,705 | 6,431,575 | 43,810,145 | $46,955,287 |
| 1912 | 5,552,164 | 175,370.74 | 12,731,638 | 309,738,873 | 7,446,749 | 26,918,881 | 64,754,613 |
| 1913 | 5,960,118 | 168,994.77 | 13,819,201 | 287,828,699 | 10,935,827 | 88,673,083 | 61,900,546 |
| 1914 | 5,128,956 | 199,203.94 | 12,016,460 | 233,229,640 | 9,656,008 | 111,580,544 | 47,849,747 |
| 1915 | 6,129,924 | 242,077.93 | 14,378,437 | 267,231,014 | 13,756,356 | 187,146,895 | 82,912,254 |
| 1916 | 7,860,425 | 220,130.15 | 16,494,366 | 352,928,373 | 13,595,136 | 229,259,075 | 133,882,947 |
| 1917 | 6,307,164 | 170,147.11 | 13,128,142 | 274,462,574 | 21,951,220 | 186,259,331 | 110,149,382 |
| 1918 | 7,823,967 | 150,192.96 | 16,797,479 | 323,174,850 | 37,135,875 | 209,258,148 | 121,405,569 |
| 1919 | 4,183,594 | 107,856.32 | 12,541,181 | 169,981,288 | 34,437,764 | 168,763,823 | 62,037,191 |
| 1920 | 5,241,615 | 89,550.11 | 12,579,178 | 177,059,260 | 31,253,916 | 184,337,786 | 65,573,047 |
| 1921 | 1,324,801 | 71,631.91 | 6,558,713 | 48,098,730 | 20,366,917 | 23,275,966 | 16,324,521 |
| 1922 | 4,385,878 | 80,145.62 | 12,468,151 | 165,754,442 | 29,767,479 | 119,069,818 | 44,925,949 |
| | 64,838,909 | 1,854,800.43 | 155,498,142 | 2,882,335,448 | 236,734,822 | 1,578,353,495 | 858,671,053 |

*Gold and silver produced at placer mines in Montana, 1911–1922, in fine ounces.*

| Year. | Gold. | Silver. | Year. | Gold. | Silver. |
|---|---|---|---|---|---|
| 1911 | 33,127.25 | 5,123 | 1918 | 19,167.72 | 3,166 |
| 1912 | 39,010.52 | 5,852 | 1919 | 14,097.92 | 2,309 |
| 1913 | 38,748.47 | 5,623 | 1920 | 13,977.76 | 2,210 |
| 1914 | 45,579.75 | 7,041 | 1921 | 10,988.91 | 1,591 |
| 1915 | 45,919.87 | 7,775 | 1922 | 3,472.65 | 652 |
| 1916 | 34,982.82 | 5,342 | | | |
| 1917 | 22,594.17 | 3,551 | | 321,667.81 | 50,235 |

*Content of ore sold or treated in Montana, 1911–1922.*

**Dry and siliceous ore.**

| Year. | Ore. | Gold. | Silver. | Copper. | Lead. | Recoverable zinc. |
|---|---|---|---|---|---|---|
| | *Short tons.* | *Fine ounces.* | *Fine ounces.* | *Pounds.* | *Pounds.* | *Pounds.* |
| 1911 | 369,241 | 111,487.49 | 1,613,253 | 288,183 | 1,727,853 | ..... |
| 1912 | 298,308 | 98,779.72 | 1,318,505 | 1,066,385 | 627,552 | ..... |
| 1913 | 284,488 | 92,749.19 | 1,335,602 | 676,184 | 180,678 | ..... |
| 1914 | 342,085 | 121,599.07 | 1,249,555 | 742,887 | 39,970 | ..... |
| 1915 | 493,500 | 155,055.51 | 1,635,221 | 896,903 | 22,772 | 52,429 |
| 1916 | 523,842 | 135,427.26 | 1,175,791 | 380,364 | 42,759 | ..... |
| 1917 | 444,222 | 107,172.83 | 954,477 | 543,456 | 268,464 | ..... |
| 1918 | 286,522 | 80,613.50 | 1,028,443 | 251,764 | 33,264 | ..... |
| 1919 | 221,686 | 64,289.55 | 1,707,053 | 396,501 | 140,694 | ..... |
| 1920 | 178,352 | 45,293.42 | 2,000,162 | 358,808 | 611,004 | ..... |
| 1921 | 164,906 | 47,377.95 | 1,546,910 | 85,468 | 956,655 | ..... |
| 1922 | 373,311 | 53,343.24 | 2,197,802 | 217,906 | 581,205 | ..... |
| | 3,980,463 | 1,113,188.73 | 17,762,774 | 5,904,809 | 5,232,870 | 52,429 |

**Copper ore.**

| | | | | | | |
|---|---|---|---|---|---|---|
| 1911 | 4,332,479 | 31,300.27 | 9,597,752 | 271,079,252 | 2,005 | ..... |
| 1912 | 5,094,432 | 34,200.83 | 10,655,055 | 308,274,462 | 3,527 | ..... |
| 1913 | 5,335,851 | 32,084.86 | 10,311,807 | 286,393,731 | 20,456 | ..... |
| 1914 | 4,346,034 | 25,422.61 | 8,015,694 | 231,019,109 | 13,871 | ..... |
| 1915 | 4,863,378 | 30,840.90 | 8,819,772 | 263,044,912 | ..... | ..... |
| 1916 | 6,197,978 | 38,235.21 | 11,226,034 | 348,645,332 | 12,338 | ..... |
| 1917 | 4,844,537 | 27,561.56 | 8,911,389 | 271,331,853 | 820 | ..... |
| 1918 | 6,412,941 | 32,464.51 | 10,521,219 | 316,740,920 | ..... | ..... |
| 1919 | 3,081,451 | 16,612.99 | 6,341,825 | 165,321,847 | ..... | ..... |
| 1920 | 4,002,491 | 18,720.88 | 6,030,507 | 172,581,159 | 1,847 | ..... |
| 1921 | 928,461 | 4,733.30 | 1,663,472 | 46,888,812 | 1,029 | ..... |
| 1922 | 3,250,213 | 13,367.13 | 5,446,684 | 162,860,743 | ..... | ..... |
| | 52,690,246 | 305,545.05 | 97,541,210 | 2,844,182,132 | 55,893 | ..... |

**Lead ore.**

| | | | | | | |
|---|---|---|---|---|---|---|
| 1911 | 11,692 | 2,717.90 | 186,926 | 35,623 | 3,047,382 | ..... |
| 1912 | 20,993 | 2,181.28 | 266,014 | 48,436 | 4,860,009 | ..... |
| 1913 | 27,270 | 2,114.18 | 493,326 | 97,826 | 5,680,139 | ..... |
| 1914 | 29,636 | 1,972.44 | 388,194 | 25,603 | 3,879,401 | ..... |
| 1915 | 13,783 | 3,809.00 | 407,859 | 87,748 | 4,278,280 | ..... |
| 1916 | 7,231 | 2,066.39 | 180,601 | 35,812 | 2,064,037 | ..... |
| 1917 | 28,923 | 4,688.65 | 388,435 | 55,780 | 5,554,911 | ..... |
| 1918 | 31,423 | 4,747.38 | 707,757 | 178,809 | 6,537,297 | ..... |
| 1919 | 33,551 | 3,797.15 | 747,960 | 192,927 | 6,753,703 | ..... |
| 1920 | 64,563 | 3,084.34 | 800,856 | 199,951 | 9,583,916 | ..... |
| 1921 | 113,481 | 4,151.98 | 1,352,125 | 215,114 | 7,414,293 | 11,167 |
| 1922 | 96,203 | 2,783.02 | 647,754 | 33,275 | 8,133,697 | ..... |
| | 478,749 | 38,113.71 | 6,567,807 | 1,206,904 | 67,787,065 | 11,167 |

*Content of ore sold or treated in Montana, 1911–1922*—Continued.

**Copper-lead ore.**

| Year. | Ore. | Gold. | Silver. | Copper. | Lead. | Recoverable zinc. |
|---|---|---|---|---|---|---|
| | *Short tons.* | *Fine ounces.* | *Fine ounces.* | *Pounds.* | *Pounds.* | *Pounds.* |
| 1911 | 1,177 | 48.81 | 90,981 | 104,220 | 790,209 | ..... |
| 1912 | 1,788 | 102.07 | 80,688 | 118,166 | 680,173 | ..... |
| 1913 | 1,054 | 32.85 | 14,557 | 64,083 | 283,323 | ..... |
| 1914 | 168 | 6.63 | 5,271 | 22,215 | 78,147 | ..... |
| 1915 | 215 | 5.18 | 4,045 | 22,838 | 42,363 | ..... |
| 1916 | 1,696 | 485.20 | 87,520 | 176,833 | 759,540 | ..... |
| 1917 | 3,344 | 223.45 | 95,747 | 156,675 | 1,073,182 | ..... |
| 1918 | 253 | 32.02 | 2,304 | 10,086 | 81,775 | ..... |
| 1919 | 971 | 90.08 | 58,335 | 86,416 | 480,662 | ..... |
| 1920 | 1,787 | 113.83 | 38,685 | 62,508 | 375,072 | ..... |
| 1921 | 334 | 10.59 | 26,244 | 24,388 | 166,526 | ..... |
| 1922 | 21,251 | 659.18 | 122,153 | 204,497 | 518,697 | ..... |
| | 34,038 | 1,809.89 | 626,530 | 1,052,925 | 5,329,669 | ..... |

**Zinc ore and lead-zinc ore.**

| | | | | | | |
|---|---|---|---|---|---|---|
| 1911 | 225,714 | 817.15 | 491,161 | 1,340,427 | 864,126 | 43,810,145 |
| 1912 | 136,643 | 1,096.32 | 405,524 | 231,424 | 1,275,488 | 26,918,881 |
| 1913 | 311,455 | 3,265.22 | 1,658,286 | 596,875 | 4,771,231 | 88,673,083 |
| 1914 | 411,033 | 4,623.44 | 2,350,705 | 1,419,826 | 5,644,619 | 111,580,544 |
| 1915 | 759,048 | 6,447.47 | 3,503,765 | 3,178,613 | 9,412,941 | 187,094,466 |
| 1916 | 1,091,265 | 8,736.87 | 3,767,551 | 3,533,899 | 10,713,820 | 225,394,740 |
| 1917 | 985,126 | 7,848.45 | 2,765,063 | 2,349,210 | 14,995,843 | 186,134,466 |
| 1918 | 1,092,828 | 13,167.83 | 4,534,590 | 5,993,271 | 30,483,539 | 209,258,148 |
| 1919 | 845,549 | 8,938.64 | 3,678,353 | 3,972,397 | 27,039,405 | 168,727,223 |
| 1920 | 993,177 | 8,244.89 | 3,698,319 | 3,832,870 | 20,642,223 | 184,255,271 |
| 1921 | 117,619 | 4,369.18 | 1,968,371 | 884,948 | 11,828,414 | 23,264,799 |
| 1922 | 644,900 | 6,520.40 | 4,053,106 | 2,438,021 | 20,533,880 | 119,069,818 |
| | 7,614,357 | 74,075.86 | 32,874,794 | 29,771,781 | 158,205,529 | 1,574,181,584 |

## ORE.

The ore sold or treated in Montana in 1922 was more than three times that of 1921, but the average value decreased from $12.15 a ton to $10.23. More than 68 per cent of the ore was concentrated, 3 per cent was treated in gold and silver mills, and more than 4 per cent was shipped directly to smelters. The remainder, more than 24 per cent, consisted of ore leached, slag, and old tailings, which were concentrated or cyanided. Mines in Silver Bow County produced more than 91 per cent of the total ore. The dry and siliceous ore was principally silver ore and gold ore. The gold ore included much iron ore from Deer Lodge and Broadwater counties used at the smelters for fluxing. Copper ore amounted to more than 74 per cent of the total ore mined, and zinc ore to more than 9 per cent. The different kinds of first-class shipping ore and concentrates with their contents are given in the tables on pages 464–465. Copper ore and copper concentrates exceeded all other kinds.

*Ore and metals produced in Montana in 1922.*

| Source of production. | Ore. | | Gold. | | Silver. | |
|---|---|---|---|---|---|---|
| | Short tons. | Per cent. | Fine ounces. | Per cent. | Fine. ounces. | Per cent. |
| Dry gold ore | 161,900 | 3.69 | 42,695.72 | 53.27 | 44,158 | 0.35 |
| Dry gold and silver ore | 6,594 | .15 | 1,079.35 | 1.35 | 19,242 | .15 |
| Dry silver ore | 204,817 | 4.67 | 9,568.17 | 11.94 | 2,134,402 | 17.12 |
| Copper ore | 3,250,213 | 74.11 | 13,367.13 | 16.68 | 5,446,684 | 43.69 |
| Lead ore | 96,203 | 2.19 | 2,783.02 | 3.47 | 647,754 | 5.20 |
| Zinc ore | 399,330 | 9.10 | 2,276.81 | 2.84 | 1,661,234 | 13.32 |
| Copper-lead ore | 21,251 | .49 | 659.18 | .82 | 122,153 | .98 |
| Lead-zinc ore | 245,570 | 5.60 | 4,243.59 | 5.30 | 2,391,872 | 19.18 |
| Total deep mines | 4,385,878 | 100.00 | 76,672.97 | 95.67 | 12,467,499 | 99.99 |
| Total placers | | | 3,472.65 | 4.33 | 652 | .01 |
| Total, deep and placers, 1922 | 4,385,878 | 100.00 | 80,145.62 | 100.00 | 12,468,151 | 100.00 |
| Total, deep and placers, 1921 | 1,324,801 | | 71,631.91 | | 6,558,713 | |
| Increase, 1922 | 3,061,077 | | 8,513.71 | | 5,909,438 | |

| Source of production. | Copper. | | Lead. | | Zinc. | |
|---|---|---|---|---|---|---|
| | Pounds. | Per cent. | Pounds. | Per cent. | Pounds. | Per cent. |
| Dry gold ore | 11,306 | 0.01 | 13,441 | 0.05 | | |
| Dry gold and silver ore | 18,282 | .01 | 2,125 | .01 | | |
| Dry silver ore | 188,318 | .12 | 565,639 | 1.90 | | |
| Copper ore | 162,860,743 | 98.25 | | | | |
| Lead ore | 33,275 | .02 | 8,133,697 | 27.32 | | |
| Zinc ore | 1,038,992 | .63 | 7,279,566 | 24.45 | 89,966,386 | 75.56 |
| Copper-lead ore | 204,497 | .12 | 518,697 | 1.74 | | |
| Lead-zinc ore | 1,399,029 | .84 | 13,254,314 | 44.53 | 29,103,432 | 24.44 |
| Total deep mines | 165,754,442 | 100.00 | 29,767,479 | 100.00 | 119,069,818 | 100.00 |
| Total deep mines, 1921 | 48,098,730 | | 20,366,917 | | 23,275,966 | |
| Increase, 1922 | 117,655,712 | | 9,400,562 | | 95,793,852 | |

## GOLD ORE.

The gold ore, largely dry and siliceous, was mined by 77 producers in 1922, compared with 104 producers in 1921. This ore averaged $5.45 in gold and 0.27 ounce of silver to the ton and was valued at $5.74 a ton. Park, Jefferson, and Phillips counties produced much gold ore, but Lewis and Clark County produced gold ore of better grade.

*Content of dry gold ore sold or treated in Montana in 1922.*

| County. | Ore. | Gold. | Silver. | Copper. | Lead. |
|---|---|---|---|---|---|
| | *Short tons.* | *Fine ounces.* | *Fine ounces.* | *Pounds.* | *Pounds.* |
| Beaverhead | 84 | 309.46 | 141 | 904 | |
| Broadwater | 8,495 | 1,471.62 | 750 | 212 | |
| Deer Lodge | 7,899 | 1,752.80 | | | |
| Fergus | 5,023 | 1,440.11 | 527 | | |
| Granite | 2,961 | 1,690.11 | 2,983 | 1,856 | |
| Jefferson | 31,983 | 5,321.80 | 1,039 | 48 | 328 |
| Lewis and Clark | 27,678 | 12,025.88 | 14,156 | | |
| Madison | 14,366 | 7,210.78 | 15,279 | 8,286 | 12,281 |
| Meagher | 23 | 84.74 | 13 | | |
| Missoula | 77 | 109.67 | 19 | | |
| Park | 36,883 | 7,833.99 | 1,325 | | |
| Phillips | 26,400 | 3,412.00 | 7,733 | | |
| Powell | 9 | 8.40 | 88 | | 319 |
| Silver Bow | 19 | 24.36 | 105 | | 513 |
| | 161,900 | 42,695.72 | 44,158 | 11,306 | 13,441 |

## GOLD AND SILVER ORE.

Gold and silver ore was mined in five counties by 12 producers. The average of the output was $3.38 in gold and 2.92 ounces of silver to the ton, 0.14 per cent of copper, and 0.02 per cent of lead. This class of ore was produced largely from the Alder Gulch district, Madison County, where the Marietta mine was the main contributor.

*Content of dry gold and silver ore sold or treated in Montana in 1922.*

| County. | Ore. | Gold. | Silver. | Copper. | Lead. |
|---|---|---|---|---|---|
| | *Short tons.* | *Fine ounces.* | *Fine ounces.* | *Pounds.* | *Pounds.* |
| Jefferson | 991 | 309.65 | 7,201 | 16,938 | ..... |
| Lewis and Clark | 22 | 36.87 | 643 | ..... | ..... |
| Madison | 5,559 | 723.66 | 11,227 | 1,155 | 1,837 |
| Meagher | 9 | 4.97 | 120 | 189 | ..... |
| Powell | 13 | 4.20 | 51 | ..... | 288 |
| | 6,594 | 1,079.35 | 19,242 | 18,282 | 2,125 |

## SILVER ORE.

The output of siliceous silver ore was mined by 118 producers and averaged 97 cents in gold and 10.42 ounces of silver to the ton, 0.05 per cent of copper, and 0.14 per cent of lead. A marked increase was shown in this class of ore, which is becoming prominent, especially in the Butte district. Some of the large producers of silver ore were the Granite-Bimetallic mine, in Granite County; the Hartley mine, in Cascade County; the Elkhorn dump, in Jefferson County; and the Goldsmith, Garfield Salvador, Elm Orlu, Anaconda, and Davis Daly properties, in Silver Bow County.

*Content of dry silver ore sold or treated in Montana in 1922.*

| County. | Ore. | Gold. | Silver. | Copper. | Lead. |
|---|---|---|---|---|---|
| | *Short tons.* | *Fine ounces.* | *Fine ounces.* | *Pounds.* | *Pounds.* |
| Beaverhead | 320 | 10.92 | 12,258 | 493 | 126 |
| Broadwater | 196 | 8.22 | 5,124 | 244 | 6,409 |
| Cascade | 11,726 | 304.73 | 234,331 | 56 | 532,431 |
| Deer Lodge | 29,666 | 579.00 | 199,480 | ..... | ..... |
| Fergus | 52 | 2.94 | 2,430 | ..... | ..... |
| Granite | 12,431 | 1,113.40 | 459,743 | 10,675 | 11,020 |
| Jefferson | 24,963 | 677.45 | 112,853 | 18,268 | 902 |
| Lewis and Clark | 147 | 4.90 | 4,584 | 6 | 1,079 |
| Madison | 457 | 177.94 | 11,833 | 762 | ..... |
| Powell | 137 | 117.30 | 6,111 | 363 | 9,177 |
| Ravalli | 2 | .05 | 70 | 39 | ..... |
| Sanders | 5 | ..... | 1,140 | 244 | 306 |
| Silver Bow | 124,715 | 6,571.32 | 1,084,445 | 157,168 | 4,189 |
| | 204,817 | 9,568.17 | 2,134,402 | 188,318 | 565,639 |

## COPPER ORE.

Copper ore from 25 producers represented more than 74 per cent of the total ore output. The average content of copper ore was 9 cents in gold, 1.68 ounces of silver, and 50.11 pounds of copper, and the average value was $8.53 a ton. Nearly all the copper ore is mined at Butte, largely from the Anaconda, North Butte, East Butte, and Davis Daly properties.

*Content of copper ore sold or treated in Montana in 1922.*

| County. | Ore. | Gold. | Silver. | Copper. |
|---|---|---|---|---|
| | *Short tons.* | *Fine ounces.* | *Fine ounces.* | *Pounds.* |
| Broadwater | 26 | 12.42 | 86 | 1,493 |
| Granite | 105 | 2.64 | 1,157 | 13,974 |
| Jefferson | 636 | 124.50 | 7,502 | 38,195 |
| Lewis and Clark | 27 | .13 | 545 | 6,700 |
| Meagher | 32 | .16 | 10 | 5,153 |
| Missoula | 3 | .09 | 2 | 637 |
| Sanders | 49 | 3.68 | 356 | 12,347 |
| Silver Bow | 3,249,335 | 13,223.51 | 5,437,026 | 162,782,244 |
| | 3,250,213 | 13,367.13 | 5,446,684 | 162,860,743 |

## LEAD ORE.

The output of lead ore by 90 producers was valued at $1,157,129. The average content of the ore was 60 cents in gold and 6.73 ounces of silver to the ton, 0.02 per cent of copper, and 4.23 per cent of lead. The total average value of all the metals was $12.03 a ton. Lincoln, Judith Basin, Cascade, and Jefferson counties produced most of the lead ore, and the Snow Storm, Block P., Lukens Hazel, and Hartley mines were prominent producers.

*Content of lead ore sold or treated in Montana in 1922.*

| County. | Ore. | Gold. | Silver. | Copper. | Lead. |
|---|---|---|---|---|---|
| | *Short tons.* | *Fine ounces.* | *Fine ounces.* | *Pounds.* | *Pounds.* |
| Beaverhead | 780 | 26.91 | 2,809 | 5,187 | 158,833 |
| Broadwater | 46 | 4.20 | 715 | ..... | 35,639 |
| Cascade | 7,987 | 62.70 | 352,636 | ..... | 1,018,445 |
| Deer Lodge | 108 | .79 | 4,477 | 2,677 | 28,759 |
| Granite | 593 | 23.88 | 13,063 | 518 | 126,765 |
| Jefferson | 5,587 | 540.62 | 45,081 | 3,225 | 565,673 |
| Judith Basin | 15,107 | 160.30 | 94,394 | ..... | 1,949,428 |
| Lewis and Clark | 267 | 70.69 | 9,831 | 1,022 | 85,094 |
| Lincoln | 63,679 | 509.04 | 100,335 | ..... | 3,539,539 |
| Madison | 1,161 | 512.99 | 6,269 | 20,646 | 358,540 |
| Mineral | 203 | 1.00 | 8,020 | ..... | 99,525 |
| Missoula | 46 | ..... | 276 | ..... | 17,441 |
| Park | 38 | 2.10 | 1,165 | ..... | 33,962 |
| Powell | 577 | 851.40 | 8,265 | ..... | 107,238 |
| Silver Bow | 21 | 16.10 | 211 | ..... | 5,887 |
| Sweet Grass | 3 | .30 | 207 | ..... | 2,929 |
| | 96,203 | 2,783.02 | 647,754 | 33,275 | 8,133,697 |

## COPPER-LEAD ORE.

The output of copper-lead ore was reported by four producers. The average content was 64 cents in gold and 5.75 ounces of silver to the ton, 0.48 per cent of copper, and 1.22 per cent of lead, and the average value was $9.03 a ton. Most of the output was mill ore from the Boston-Montana property and shipping ore from the Hecla mine, both in Beaverhead County.

*Content of copper-lead ore sold or treated in Montana in 1922.*

| County. | Ore. | Gold. | Silver. | Copper. | Lead. |
|---|---|---|---|---|---|
| | *Short tons.* | *Fine ounces.* | *Fine ounces.* | *Pounds.* | *Pounds.* |
| Beaverhead | 21,189 | 573.64 | 121,031 | 200,157 | 510,383 |
| Broadwater | 28 | 67.64 | 284 | 2,638 | 4,464 |
| Lewis and Clark | 34 | 17.90 | 838 | 1,702 | 3,850 |
| | 21,251 | 659.18 | 122,153 | 204,497 | 518,697 |

## LEAD-ZINC ORE AND ZINC ORE.

Lead-zinc ore, which represented nearly 6 per cent of the total output of ore, was mined by 10 producers. The average of the output was 36 cents in gold and 9.74 ounces of silver to the ton, 0.28 per cent of copper, 2.70 per cent of lead, and 5.93 per cent of zinc. The total average value of all the metals was $20.59 a ton. Most of the lead-zinc ore was produced from the mines at Butte, and all of it was milled at either Anaconda or Butte.

*Content of lead-zinc ore sold or treated in Montana in 1922.*

| County. | Ore. | Gold. | Silver. | Copper. | Lead. | Zinc. |
|---|---|---|---|---|---|---|
| | *Short tons.* | *Fine ounces.* | *Fine ounces.* | *Pounds.* | *Pounds.* | *Pounds.* |
| Granite | 8,175 | 163.67 | 177,229 | 2,580 | 393,700 | 1,124,355 |
| Jefferson | 56 | 7.12 | 1,808 | 450 | 10,800 | 3,797 |
| Silver Bow | 237,339 | 4,072.80 | 2,212,835 | 1,395,999 | 12,849,814 | 27,975,280 |
| | 245,570 | 4,243.59 | 2,391,872 | 1,399,029 | 13,254,314 | 29,103,432 |

Zinc ore was mined from three mines in the Summit Valley district, Silver Bow County. The ore contained an average of 12 cents in gold and 4.16 ounces of silver to the ton, 0.13 per cent of copper, 0.91 per cent of lead, and 11.26 per cent of zinc and was valued at $18.47 a ton.

## GOLD.

The output of gold in Montana increased nearly 12 per cent but was considerably less than the output of a normal year. In 1915 the output of gold in Montana was valued at more than $5,000,000, but it has steadily decreased since. Silver Bow County had the largest output, owing to the resumption of mining at Butte, and was followed by Lewis and Clark and Madison counties. Most of the placer gold resulted from the dredge operations in Alder Gulch, Madison County. The deposit, however, was worked out and the equipment moved late in the year. The increased output from Jefferson and Park counties was due to the renewal of operations at the Jardine and Swissmont mines. The decrease in Lewis and Clark County was due to the partial depletion of ore bodies in the Barnes King properties. Nearly 35 per cent of the gold was produced at amalgamation and cyanidation mills, which yielded an average recovery of $3.67 in gold and $0.59 in silver a ton of ore and tailings treated. More than 37 per cent of the gold was contained in concentrates of all kinds, and crude ore shipped to smelters contained

23 per cent of the total. More than 66 per cent of the gold came from dry and siliceous ore, nearly 17 per cent from copper ore, more than 4 per cent from placers, more than 5 per cent from lead-zinc ore, nearly 3 per cent from zinc ore, more than 3 per cent from lead ore, and nearly 1 per cent from copper-lead ore; gold increased from all these sources except lead ore and lead-zinc ore.

More than 53 per cent of the total gold in 1922 was produced from seven properties. The copper mines of the Anaconda Copper Mining Co. ranked first in the production of gold. The others were the Shannon property, near Marysville; the Jardine mine, in the Sheep-eater district, Park County; the Swissmont mine, near Elkhorn, Jefferson County; the Ruby Gulch, in Phillips County; and the Goldsmith and Elm Orlu mines, in Silver Bow County.

## SILVER.

Silver produced by mines in Montana in 1922 increased 90 per cent in quantity, but the output of 1921 was unusually small. Production in 1922 nearly reached the average of the last 10 years, which was about 13,000,000 ounces. Most of the silver was obtained from copper ore and lead-zinc ore; the former yielded nearly 44 per cent of the total and the latter more than 19 per cent. More than 83 per cent of the silver came from Silver Bow County, principally the Butte district. Cyanidation and amalgamation mills produced only a fraction of 1 per cent of the silver, concentrates more than 78 per cent, crude ore shipped to smelters nearly 20 per cent, and ore treated by chlorination and old slag smelted more than 1 per cent.

Twelve properties produced more than 84 per cent of the silver, and each of these produced more than 200,000 ounces. Four of the large mining properties produced more than 900,000 ounces each—the copper and zinc mines of the Anaconda Co. and the Butte & Superior, Elm Orlu, and Davis Daly mines. The other large producers were the North Butte, Neihart Consolidated, Goldsmith, Granite-Bimetallic, Philipsburg, and East Butte mines.

## COPPER.

The mine production of copper was more than three times that of 1921 but was only about 51 per cent of the output of 1918.

Silver Bow County, which includes the Butte district, contributed all the copper except 380,039 pounds. Copper ore was the source of nearly all the copper. Crude ore of all kinds shipped to smelters contained more than 6 per cent of the copper and concentrates 87 per cent. The sulphide copper ore of smelting grade contained 10,340,118 pounds, an average content of 4.39 per cent, and the oxidized ores only 17,555 pounds, an average of 6.23 per cent. Slag and copper precipitates produced from mine waters contained 11,230,626 pounds.

Six mines in Montana each produced more than 1,000,000 pounds of copper in 1922. The mines of the Anaconda Copper Mining Co. produced more than all others combined. Other large producers were the North Butte, Davis Daly, East Butte, and Butte & Superior mines.

## LEAD.

The mine production of lead in Montana increased more than 46 per cent from that of 1921, and nearly 68 per cent of the output was derived from mines in Silver Bow County. Lead-zinc ore was the source of nearly 45 per cent of the lead, lead ore yielded more than 27 per cent, zinc ore more than 24 per cent, dry and siliceous ore 2 per cent, and copper-lead ore nearly 2 per cent. Crude ore of all kinds shipped to the smelters contained more than 11 per cent of the total lead, concentrates more than 88 per cent, and old slag less than 1 per cent. Most of the first-class lead ore was sulphide.

Nearly all the lead came from seven properties, which produced more than 1,700,000 pounds each. In the order of output these were the Butte & Superior, the zinc mines of the Anaconda Co., Davis Daly, Snow Storm, Elm Orlu, Block P., and Emma & Ophir mines.

## ZINC.

The mine production of recoverable zinc in Montana was more than five times that of 1921, when many of the mines were forced to close. The increasing price of lead and zinc in 1922, together with the high price of silver, stimulated the mining of ores containing zinc and associated metals. The Butte & Superior Mining Co., the largest producer of zinc ore, resumed operations in January and steadily increased its output. Zinc ore was the source of nearly 76 per cent of the zinc, and lead-zinc ore yielded more than 24 per cent.

Seven mines at Butte produced nearly all the zinc—the Butte & Superior, Elm Orlu, Anaconda (zinc), Davis Daly, Emma, Moulton, and Poser.

## MINING INDUSTRY.

Though the metal output of the mines of Montana was not comparatively large in 1922, a decided improvement in general conditions was shown as the year advanced. After a period of depression and idleness in 1921, the large companies gradually resumed operations, and several of them tried to regain a normal rate of production. Much time was used in gaining a reasonable momentum on account of the necessary repairs after a prolonged idleness and the inexperience of many of the newly employed men. Early in the year wages were reduced, and metal prices were practically the same as those of 1921. Later the metal market improved, and in September wages were increased. The need of experienced miners was felt throughout the year in spite of the large number of men employed at Butte, Anaconda, and Great Falls. The smelting of lead ore proceeded at an increased rate, and the electrolytic zinc plant near Great Falls was operated at capacity late in the year, but the smelting of copper ore at Anaconda and Butte was carried on at about 60 per cent of the normal rate.

## METALLURGIC INDUSTRY.

Forty-one milling plants of various kinds were active in Montana in 1922, though many of them were operated for only a short period. They included 3 plants using the amalgamation process, 5 using amalgamation and concentration, 12 equipped for cyanidation, 1

using concentration and cyanidation, 1 using amalgamation, concentration, and cyanidation, 3 using table concentration, 10 using flotation equipment after table concentration, and 2 using straight flotation. Two copper-precipitating plants that extracted copper from mine waters, 1 chlorination plant, and 1 electrolytic zinc-leaching plant are included in the total. A complete list of milling plants giving the process and equipment of each for the year 1920 was prepared by the United States Geological Survey and can be obtained from the Director of the Bureau of Mines, Washington, D. C.

Of the ore and old tailings treated at gold and silver mills, 43,757 tons was treated by amalgamation, with an average recovery per ton of $3 in gold and 0.06 ounce of silver, and 113,687 tons by cyanidation, with an average recovery per ton of $3.92 in gold and 0.81 ounce of silver. During the year 218 pounds of mercury was purchased and 292,940 pounds of sodium and potassium cyanide was used in gold and silver mills. The quantity of mercury purchased represented 0.005 pound of mercury per ton of ore amalgamated and 0.0248 pound of mercury per ounce of bullion recovered. The consumption of cyanide was 2.59 pounds per ounce of gold and silver bullion and 2.58 pounds per ton of ore and tailings treated. The ore treated by these processes was more than doubled and the gold recovered by amalgamation increased, but gold won by cyanidation was less.

*Gold and silver produced at mills in Montana in 1922.*

| County. | Ore (short tons). | Bullion (fine ounces) recovered from ore by— | | | | Total value. |
|---|---|---|---|---|---|---|
| | | Amalgamation. | | Cyanidation. | | |
| | | Gold. | Silver. | Gold. | Silver. | |
| Beaverhead | 35 | 21.13 | 7 | 0.44 | 826 | $1,279 |
| Broadwater | 36 | 234.55 | 48 | ..... | ..... | 4,896 |
| Fergus | 5,023 | ..... | ..... | 1,440.11 | 527 | 30,297 |
| Granite | [a] 1,613 | 167.51 | 16 | .55 | 1,028 | 4,518 |
| Jefferson | 31,965 | 6.87 | 3 | [b] 5,483.30 | [b] 72,170 | 185,665 |
| Lewis and Clark | 25,454 | 33.85 | 12 | [c] 10,661.99 | [c] 8,252 | 229,367 |
| Madison | [d] 6,250 | 2,937.81 | 1,815 | 563.33 | 1,011 | 75,201 |
| Missoula | 55 | 51.97 | 4 | ..... | ..... | 1,078 |
| Park | [e] 36,883 | 2,904.92 | 520 | ..... | ..... | 60,570 |
| Phillips | 26,400 | ..... | ..... | 3,412.00 | 7,733 | 78,265 |
| | 133,714 | 6,358.61 | 2,425 | 21,561.72 | 91,547 | 671,136 |

[a] Also yielded 78 tons of concentrates.
[b] Includes bullion from 22,155 tons of tailings, which also yielded 225 tons of concentrates.
[c] Includes bullion from 1,575 tons of tailings.
[d] Also yielded 98 tons of concentrates.
[e] Also yielded 2,771 tons of concentrates.

Mills in Montana equipped for the concentration of low-grade ore treated 68 per cent of the ore mined. The concentrates produced had an average value of $36.61 a ton. The increase in quantity was general but especially marked in copper concentrate and zinc concentrate.

*Mine production of metals from Montana concentrates, 1922.*

**By counties.**

| County. | Ore to concentrating mills. | Concentrates. | Gold. | Silver. | Copper. | Lead. | Recoverable zinc. | Total value of concentrates. |
|---|---|---|---|---|---|---|---|---|
| | *Short tons.* | *Short tons.* | *Fine ounces.* | *Fine ounces.* | *Pounds.* | *Pounds.* | *Pounds.* | |
| Beaverhead | 20,827 | 3,104 | 559.94 | 90,357 | 169,001 | 303,545 | ..... | $141,442 |
| Broadwater | 8,452 | 2,113 | 1,220.87 | 614 | 212 | ..... | ..... | 25,881 |
| Deer Lodge | 29,666 | 836 | 579.00 | 199,480 | ..... | ..... | ..... | 211,449 |
| Granite | 9,275 | 2,041 | 880.57 | 178,397 | 3,968 | 393,700 | 1,124,355 | 282,878 |
| Jefferson | 4,356 | 1,534 | 397.82 | 53,400 | 450 | 372,236 | 3,797 | 82,375 |
| Judith Basin | 14,450 | 2,637 | 131.60 | 73,630 | ..... | 1,492,832 | ..... | 158,456 |
| Lincoln | 63,667 | 3,949 | 489.84 | 100,293 | ..... | 3,537,499 | ..... | 304,981 |
| Madison | 12,682 | 540 | 1,930.55 | 18,974 | 4,385 | 14,000 | ..... | 60,244 |
| Park | ..... | 2,771 | 4,929.07 | 805 | ..... | ..... | ..... | 102,698 |
| Silver Bow | 2,833,964 | 1,019,492 | 18,685.53 | 9,033,858 | 143,810,722 | 20,129,380 | 117,941,666 | 36,664,360 |
| | 2,997,339 | 1,039,017 | 29,804.79 | 9,749,808 | 143,988,738 | 26,243,192 | 119,069,818 | 38,034,764 |

**By kinds of concentrates.**

| | | | | | | | | |
|---|---|---|---|---|---|---|---|---|
| Dry and siliceous | ..... | 11,325 | 9,574.79 | 373,203 | 101,845 | 9,229 | ..... | $585,388 |
| Copper | ..... | 858,714 | 12,220.07 | 5,060,161 | 141,345,566 | ..... | ..... | 24,394,424 |
| Lead | ..... | 17,588 | 2,814.44 | 1,062,679 | 215,135 | 9,955,193 | ..... | 1,697,438 |
| Zinc | ..... | 114,313 | 2,777.80 | 1,889,498 | 1,254,312 | 8,240,266 | 101,789,682 | 8,371,479 |
| Copper-lead | ..... | 2,014 | 421.10 | 64,936 | 103,306 | 303,545 | ..... | 104,282 |
| Lead-zinc | ..... | 35,063 | 1,996.59 | 1,299,331 | 968,574 | 7,734,959 | 17,280,136 | 2,881,753 |

**Average content.**

| Kind of concentrates. | Concentrates. | Gold. | Silver. | Copper. | Lead. | Recoverable zinc. | Total value. |
|---|---|---|---|---|---|---|---|
| | *Short tons.* | *Fine ounces per ton.* | *Fine ounces per ton.* | *Per cent.* | *Per cent.* | *Per cent.* | |
| Dry and siliceous | 11,325 | 0.85 | 32.95 | 0.45 | 0.04 | ..... | $51.69 |
| Copper | 858,714 | .01 | 5.89 | 8.23 | ..... | ..... | 28.41 |
| Lead | 17,588 | .16 | 60.42 | .61 | 28.30 | ..... | 96.51 |
| Zinc | 114,313 | .02 | 16.53 | .55 | 3.60 | 44.52 | 73.23 |
| Copper-lead | 2,014 | .21 | 32.24 | 2.56 | 7.54 | ..... | 51.78 |
| Lead-zinc | 35,063 | .06 | 37.06 | 1.38 | 11.03 | 24.64 | 82.19 |
| | 1,039,017 | .03 | 9.38 | 6.93 | 1.26 | 5.73 | 36.61 |

Crude ore directly smelted averaged $22.50 a ton, and a large increase in quantity was recorded in copper and siliceous ore.

*Mine production of metals from Montana crude ore shipped to smelters in 1922.*

**By counties.**

| County. | Ore. | Gold. | Silver. | Copper. | Lead. | Total value. |
|---|---|---|---|---|---|---|
| | *Short tons.* | *Fine ounces.* | *Fine ounces.* | *Pounds.* | *Pounds.* | |
| Beaverhead | 846 | 339.42 | 43,456 | 32,553 | 256,741 | $68,988 |
| Broadwater | 303 | 108.68 | 6,297 | 4,375 | 46,512 | 11,693 |
| Cascade | 19,713 | 367.43 | 586,967 | 56 | 1,550,876 | 679,869 |
| Deer Lodge | 8,007 | 1,753.59 | 4,477 | 2,677 | 28,759 | 42,670 |
| Fergus | 52 | 2.94 | 2,430 | ..... | ..... | 2,491 |
| Granite | 13,377 | 1,945.07 | 474,734 | 25,635 | 137,785 | 525,981 |
| Jefferson | 4,968 | 1,049.75 | 43,526 | 74,434 | 136,699 | 82,793 |
| Judith Basin | 657 | 28.70 | 20,764 | ..... | 456,596 | 46,470 |
| Lewis and Clark | 1,146 | 1,460.53 | 22,333 | 9,430 | 90,023 | 58,749 |
| Lincoln | 12 | 19.20 | 42 | ..... | 2,040 | 551 |
| Madison | 2,611 | 3,193.68 | 22,808 | 26,464 | 358,658 | 112,126 |
| Meagher | 64 | 89.87 | 143 | 5,342 | ..... | 2,722 |
| Mineral | 203 | 1.00 | 8,020 | ..... | 99,525 | 13,515 |
| Missoula | 71 | 57.79 | 293 | 637 | 17,441 | 2,533 |
| Park | 38 | 2.10 | 1,165 | ..... | 33,962 | 3,076 |
| Powell | 736 | 981.30 | 14,515 | 363 | 117,022 | 41,285 |
| Ravalli | 2 | .05 | 70 | 39 | ..... | 76 |
| Sanders | 54 | 3.68 | 1,496 | 12,591 | 306 | 3,289 |
| Silver Bow | 144,907 | 7,072.01 | 1,207,804 | 10,340,482 | 10,589 | 2,750,542 |
| Sweet Grass | 3 | .30 | 207 | ..... | 2,929 | 374 |
| | 197,770 | 18,477.09 | 2,461,547 | 10,535,078 | 3,346,463 | 4,449,793 |

**By kinds of ore.**

| | | | | | | |
|---|---|---|---|---|---|---|
| Dry and siliceous | 67,037 | 15,749.87 | 1,644,749 | 116,061 | 567,205 | $2,017,192 |
| Copper | 117,960 | 878.80 | 343,373 | 10,357,673 | ..... | 1,759,825 |
| Lead | 12,349 | 1,749.18 | 441,629 | 25,848 | 2,564,106 | 622,304 |
| Copper-lead | 424 | 99.24 | 31,796 | 35,496 | 215,152 | 50,472 |

**Average content.**

| | | *Fine ounces. per ton.* | *Fine ounces. per ton.* | *Per cent.* | *Per cent.* | |
|---|---|---|---|---|---|---|
| Dry and siliceous | 67,037 | 0.23 | 24.53 | 0.09 | 0.42 | $30.09 |
| Copper: | | | | | | |
| Oxidized | 141 | ..... | ..... | 6.23 | ..... | 16.81 |
| Sulphide | 117,819 | .01 | 2.91 | 4.39 | ..... | 14.92 |
| Lead: | | | | | | |
| Oxidized | 780 | .48 | 25.75 | .10 | 15.69 | 53.08 |
| Sulphide | 11,569 | .12 | 36.44 | .10 | 10.03 | 50.21 |
| Copper-lead: | | | | | | |
| Oxidized | 396 | .08 | 79.58 | 4.15 | 26.60 | 121.69 |
| Sulphide | 28 | 2.42 | 10.14 | 4.71 | 7.97 | 81.54 |
| | 197,770 | .09 | 12.45 | 2.67 | .85 | 22.50 |

## PRODUCTION BY COUNTIES.

### GENERAL FEATURES.

In the following pages no mention is made of many districts in which production was small.

*Mine production of gold, silver, copper, lead, and zinc in Montana in 1922.*

| County. | Gold. | | | | | Silver. | |
|---|---|---|---|---|---|---|---|
| | Placers. | | Deep mines. | | Total value. | Fine ounces. | Value. |
| | Fine ounces. | Value. | Fine ounces. | Value. | | | |
| Beaverhead | 76.04 | $1,572 | 920.92 | $19,037 | $20,609 | 136,244 | $136,244 |
| Broadwater | 51.86 | 1,072 | 1,564.11 | 32,333 | 33,405 | 6,966 | 6,966 |
| Cascade | .87 | 18 | 367.41 | 7,595 | 7,613 | 586,967 | 586,967 |
| Deer Lodge | 25.78 | 533 | 2,332.60 | 48,219 | 48,752 | 203,957 | 203,957 |
| Fergus | 1.89 | 39 | 1,443.07 | 29,831 | 29,870 | 2,957 | 2,957 |
| Gallatin | 1.31 | 27 | | | 27 | | |
| Granite | 374.71 | 7,746 | 2,993.69 | 61,885 | 69,631 | 654,289 | 654,289 |
| Jefferson | 12.14 | 251 | 6,981.14 | 144,313 | 144,564 | 175,487 | 175,487 |
| Judith Basin | | | 160.31 | 3,314 | 3,314 | 94,394 | 94,394 |
| Lewis and Clark | 192.73 | 3,984 | 12,156.39 | 251,295 | 255,279 | 30,625 | 30,625 |
| Lincoln | | | 509.05 | 10,523 | 10,523 | 100,335 | 100,335 |
| Madison | 1,866.16 | 38,577 | 8,625.36 | 178,302 | 216,879 | 45,001 | 45,001 |
| Meagher | 28.93 | 598 | 89.88 | 1,858 | 2,456 | 149 | 149 |
| Mineral | 261.71 | 5,410 | 1.01 | 21 | 5,431 | 8,029 | 8,029 |
| Missoula | 32.85 | 679 | 109.76 | 2,269 | 2,948 | 298 | 298 |
| Park | 17.75 | 367 | 7,836.07 | 161,986 | 162,353 | 2,493 | 2,493 |
| Phillips | | | 3,411.99 | 70,532 | 70,532 | 7,733 | 7,733 |
| Powell | 378.10 | 7,816 | 981.29 | 20,285 | 28,101 | 14,572 | 14,572 |
| Ravalli | 31.01 | 641 | .05 | 1 | 642 | 72 | 72 |
| Sanders | | | 3.68 | 76 | 76 | 1,496 | 1,496 |
| Silver Bow | 118.81 | 2,456 | 26,184.90 | 541,290 | 543,746 | 10,395,880 | 10,395,880 |
| Sweet Grass | | | .29 | 6 | 6 | 207 | 207 |
| | 3,472.65 | 71,786 | 76,672.97 | 1,584,971 | 1,656,757 | 12,468,151 | 12,468,151 |

| County. | Copper. | | Lead. | | Recoverable zinc. | | Total value. |
|---|---|---|---|---|---|---|---|
| | Pounds. | Value. | Pounds. | Value. | Pounds. | Value. | |
| Beaverhead | 206,741 | $27,910 | 669,342 | $36,814 | | | $221,577 |
| Broadwater | 4,587 | 619 | 46,512 | 2,558 | | | 43,548 |
| Cascade | 56 | 8 | 1,550,876 | 85,298 | | | 679,886 |
| Deer Lodge | 2,677 | 361 | 28,759 | 1,582 | | | 254,652 |
| Fergus | | | | | | | 32,827 |
| Gallatin | | | | | | | 27 |
| Granite | 29,603 | 3,996 | 531,485 | 29,232 | 1,124,355 | $64,088 | 821,236 |
| Jefferson | 77,124 | 10,412 | 577,703 | 31,774 | 3,797 | 217 | 362,454 |
| Judith Basin | | | 1,949,428 | 107,218 | | | 204,926 |
| Lewis and Clark | 9,430 | 1,273 | 90,023 | 4,951 | | | 292,128 |
| Lincoln | | | 3,539,539 | 194,675 | | | 305,533 |
| Madison | 30,849 | 4,165 | 372,658 | 20,496 | | | 286,541 |
| Meagher | 5,342 | 721 | | | | | 3,326 |
| Mineral | | | 99,525 | 5,474 | | | 18,934 |
| Missoula | 637 | 86 | 17,441 | 959 | | | 4,291 |
| Park | | | 33,962 | 1,868 | | | 166,714 |
| Phillips | | | | | | | 78,265 |
| Powell | 363 | 49 | 117,022 | 6,436 | | | 49,158 |
| Ravalli | 39 | 5 | | | | | 719 |
| Sanders | 12,591 | 1,700 | 306 | 17 | | | 3,289 |
| Silver Bow | 165,374,403 | 22,325,545 | 20,139,969 | 1,107,698 | 117,941,666 | 6,722,675 | 41,095,544 |
| Sweet Grass | | | 2,929 | 161 | | | 374 |
| | 165,754,442 | 22,376,850 | 29,767,479 | 1,637,211 | 119,069,818 | 6,786,980 | 44,925,949 |

*Ore sold or treated, mines producing, and average value per ton of ores in Montana in 1921 and 1922.*

| County. | Ore sold or treated, 1922 (short tons). | | Number of deep mines producing. | | Average value per ton.[a] | | Average value per ton in gold and silver.[a] | |
|---|---|---|---|---|---|---|---|---|
| | Quantity. | Increase or decrease. | 1921 | 1922 | 1921 | 1922 | 1921 | 1922 |
| Beaverhead | 22,373 | +16,285 | 15 | 10 | $10.40 | $9.83 | $7.89 | $6.94 |
| Broadwater | 8,791 | +5,763 | 20 | 12 | 20.25 | 4.83 | 15.97 | 4.47 |
| Cascade | 19,713 | +5,185 | 17 | 17 | 40.46 | 34.49 | 35.80 | 30.16 |
| Deer Lodge | 37,673 | +11,129 | 5 | 6 | 8.41 | 6.75 | 6.41 | 6.69 |
| Fergus | 5,075 | −10,043 | 3 | 9 | 5.46 | 6.46 | 5.46 | 6.46 |
| Granite | 24,265 | +8,938 | 32 | 30 | 41.25 | 33.52 | 38.66 | 29.51 |
| Jefferson | 64,216 | +48,024 | 67 | 51 | 11.92 | 5.64 | 9.46 | 4.98 |
| Judith Basin | 15,107 | +10,174 | 9 | 8 | 36.08 | 13.56 | 20.41 | 6.47 |
| Lewis and Clark | 28,175 | −21,689 | 36 | 38 | 8.76 | 10.23 | 8.35 | 10.01 |
| Lincoln | 63,679 | +48,668 | 3 | 3 | 5.58 | 4.80 | 2.52 | 1.74 |
| Madison | 21,543 | +5,302 | 57 | 49 | 19.59 | 11.49 | 17.84 | 10.35 |
| Meagher | 64 | +64 | ..... | 4 | ..... | 42.53 | ..... | 31.27 |
| Mineral | 203 | +143 | 3 | 1 | 54.28 | 66.58 | 40.62 | 39.61 |
| Missoula | 121 | +2 | 2 | 3 | 28.02 | 28.66 | 11.98 | 20.36 |
| Park | 36,921 | +36,914 | 2 | 3 | 35.57 | 4.51 | 26.00 | 4.45 |
| Phillips | 26,400 | +26,400 | ..... | 1 | ..... | 2.96 | ..... | 2.96 |
| Powell | 736 | +67 | 15 | 13 | 51.97 | 56.09 | 42.13 | 47.28 |
| Ravalli | 2 | +1 | 1 | 1 | 217.00 | 38.00 | 217.00 | 35.50 |
| Sanders | 54 | +1 | 3 | 4 | 34.04 | 60.90 | 23.36 | 29.11 |
| Silver Bow | 4,010,759 | +2,869,746 | 58 | 51 | 11.56 | 10.25 | 4.61 | 2.73 |
| Sweet Grass | 3 | +3 | ..... | 1 | ..... | 124.67 | ..... | 71.00 |
| | 4,385,878 | +3,061,077 | 348 | 315 | 12.15 | 10.23 | 5.90 | 3.20 |

[a] Value per ton, placer product excluded.

*Number and production of producing placer mines in Montana in 1921 and 1922.*

| County. | 1921 | | | | | | 1922 | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | Mines. | | | Gold. | Silver (fine ounces). | Total value. | Mines. | | | Gold. | Silver (fine ounces). | Total value. |
| | Hydraulic, dry, and sluicing. | Dredging. | Drift. | | | | Hydraulic, dry, and sluicing. | Dredging. | Drift. | | | |
| Beaverhead | 5 | .... | 1 | $1,037 | 6 | $1,043 | 6 | .... | .... | $1,572 | 5 | $1,577 |
| Broadwater | 9 | .... | .... | 2,386 | 17 | 2,403 | 4 | .... | 1 | 1,072 | 7 | 1,079 |
| Cascade | ..... | ..... | ..... | ..... | ..... | ..... | 1 | .... | .... | 18 | ..... | 18 |
| Deer Lodge | 1 | .... | .... | 108 | ..... | 108 | 3 | .... | .... | 533 | ..... | 533 |
| Fergus | 1 | .... | .... | 220 | 1 | 221 | 1 | .... | .... | 39 | ..... | 39 |
| Gallatin | ..... | ..... | ..... | ..... | ..... | ..... | 1 | .... | .... | 27 | ..... | 27 |
| Granite | 8 | .... | .... | 734 | 2 | 736 | 3 | .... | .... | 7,746 | 114 | 7,860 |
| Jefferson | 9 | .... | .... | 1,037 | 14 | 1,051 | 5 | .... | .... | 251 | 3 | 254 |
| Lewis and Clark | 17 | .... | .... | 4,806 | 65 | 4,871 | 9 | .... | 3 | 3,984 | 28 | 4,012 |
| Lincoln | 2 | .... | .... | 325 | 2 | 327 | ..... | ..... | ..... | ..... | ..... | ..... |
| Madison | 4 | 1 | .... | 191,121 | 1,354 | 192,475 | 4 | 1 | 1 | 38,577 | 393 | 38,970 |
| Meagher | 2 | .... | .... | 236 | 3 | 239 | 2 | .... | .... | 598 | 6 | 604 |
| Mineral | 8 | .... | .... | 7,797 | 10 | 7,807 | 10 | .... | .... | 5,410 | 9 | 5,419 |
| Missoula | 9 | .... | .... | 2,349 | 5 | 2,354 | 4 | .... | .... | 679 | 1 | 680 |
| Park | 2 | .... | 1 | 928 | 7 | 935 | 2 | .... | 1 | 367 | 3 | 370 |
| Powell | 11 | .... | 1 | 8,969 | 65 | 9,034 | 8 | .... | 1 | 7,816 | 57 | 7,873 |
| Ravalli | 2 | .... | .... | 1,987 | 7 | 1,994 | 2 | .... | .... | 641 | 2 | 643 |
| Silver Bow | 3 | .... | .... | 3,121 | 33 | 3,154 | 5 | .... | .... | 2,456 | 24 | 2,480 |
| | 93 | 1 | 3 | 227,161 | 1,591 | 228,752 | 70 | 1 | 7 | 71,786 | 652 | 72,438 |

## BEAVERHEAD COUNTY.

*Argenta district.*—Oxidized lead ore was shipped from the Tuscarora and Midnight claims to Midvale, Utah.

*Bald Mountain district.*—Placer gold was produced from the Double Eagle and other claims near Bannack, on the west fork of Dies Creek.

*Bannack district.*—Two deep mines and one placer in the Bannack district produced 56 tons of ore, $6,261 in gold, and 105 ounces of silver, valued together at $6,366. The ore was valued at $107.03 a ton. One lot of high-grade gold ore was shipped by the Metal Mines Development Co.

*Beaverhead district.*—The I. X. L. mine, on Ruby Creek near Wisdom, produced exceptionally rich placer gold.

*Blue Wing district.*—One lot of lead ore was shipped from the Limon & Beck property and one lot of silver ore from the Delmonte claim.

*Bryant district (Melrose).*—The Hecla group, near Melrose, was operated by lessees, and several hundred tons of oxidized copper-lead ore, together with considerable lead slag, was shipped to Midvale, Utah.

*Elkhorn district (Wise River).*—The Elkhorn group of the Boston-Montana Corporation was operated about five months. The concentration-flotation plant treated about 20,000 tons of ore and made copper concentrate and copper-lead concentrate, which were shipped to Butte, Mont., and International, Utah. The property is opened by about 28,000 feet of tunnels and drifts, and 3,800 feet of development work was done in 1922. The company reports a large quantity of ore in reserve. Early in the year the company was given much unfavorable publicity by the publication of an engineer's report which stated that the ore in the mine was not sufficient to justify the refinancing of the property. Later in the year, however, finances were adjusted, the mine was operated, and a report by another engineer was published which stated that the mine had sufficient low-grade ore to run a 1,000-ton mill for several years. As a large sum of money has been spent in development, mill building, and railroad equipment, it is hoped that the metal output will be correspondingly large. Early in 1923 the property was operated under the direction of a receiver.

*Pioneer district.*—The Polaris mine, near Dillon, produced several hundred tons of dry silver ore, which was smelted at Anaconda.

## BROADWATER COUNTY.

*Backer district (Canton).*—The Slim Jim property produced gold valued at several thousand dollars from short, thin seams of quartz in slate.

*Beaver district.*—One small lot of gold ore was shipped from the Edna mine.

*Cedar Plains district (Radersburg).*—Seven deep mines and three placers in the Cedar Plains district produced 8,748 tons of ore, $28,092 in gold, 6,829 ounces of silver, 4,587 pounds of copper, and 46,512 pounds of lead, valued in all at $38,098. The ore had an average value of $4.25 a ton. Most of the output was iron ore containing a little gold and silver from the Keating mine. Dump ore was worked

in a 100-ton concentrator. The property is said to have more than 200,000 tons of developed ore underground, as well as 150,000 tons of ore in the mine dump. Ore shipments were also made from the Daisy Dandy, Hunter, Lead Crown, North Home, Mabin, and Moonbeam properties, and placer gold was produced from the Radersburg claim on Crow Creek.

*Park district (Townsend).*—The Dolcoath property was worked from March until June, and a test lot of ore was treated in a small mill. The Smith placer, on Indian Creek near Townsend, produced a little gold.

## CASCADE COUNTY.

*Mine production of gold, silver, copper, and lead in Cascade County, Mont., in 1921 and 1922.*

| Year. | Number of producers. | Ore. | Gold. | Silver. | Copper. | Lead. | Total value. |
|---|---|---|---|---|---|---|---|
| | | *Short tons.* | | *Fine ounces.* | *Pounds.* | *Pounds.* | |
| 1921 | 17 | 14,528 | $8,066 | 512,095 | 2,098 | 1,498,387 | $587,859 |
| 1922 | 18 | 19,713 | [a] 7,613 | 586,967 | 56 | 1,550,876 | 679,886 |
| Increase or decrease, 1922 | +1 | +5,185 | −453 | +74,872 | −2,042 | +52,489 | +92,027 |

[a] Includes small placer production.

The refining of copper bullion, treatment of zinc ore, and manufacture of copper rods and wire are carried on at Black Eagle, near Great Falls. The plants, which had been practically idle most of 1921, gradually resumed operations during the first quarter of 1922. The output of the electrolytic zinc plant was increased from 2,000,000 pounds of zinc in February to 10,000,000 pounds in September and averaged about 9,000,000 pounds a month for the year. Late in the year, as the price of zinc increased, zinc concentrate from the Butte mines was treated at a better rate, and the plant was operated at full capacity. It is the largest electrolytic zinc plant in the world. A similar though smaller plant was active at Trail, British Columbia, and a new one is planned by the Bunker Hill Co. at Kellogg, Idaho. The reduction works at Black Eagle and Anaconda are of unusual interest in that they mill and smelt the ores of Butte and other districts, refine the copper and zinc, and put finished metal bars and manufactured products on the western market. The production is given in the report of the Anaconda Copper Mining Co. under Silver Bow County.

Practically all the metal output of Cascade County was that of the Montana district (Neihart). The Neihart Consolidated Silver Mining Co. operated the Hartley mine and shipped an average of about 800 tons of silver ore a month. The company did 1,200 feet of development work in drifting and crosscutting and paid a dividend of $13,000. The Broadwater & Moulton property, operated by the Cascade Silver Mines Co., formerly the largest producer of the district, was practically idle, though several lots of lead ore rich in silver were shipped early in the year. Another large producer was the Galt Mining Co., which shipped sulphide lead ore and several thousand

tons of dump material containing silver and a small quantity of lead. About 1,000 tons of mixed silver ore and lead ore was shipped from the Black Bird & Silver Belt property. Other producers were the Big Seven, Florence, Hegener, Lizzie, Lucky Strike, Tom Hendricks, Ripple, Queen, Snow Creek, and Peabody mines. A controlling interest in the Silver Dyke property was purchased by the American Zinc, Lead & Smelting Co. The mine is said to have a large deposit of low-grade ore containing silver, lead, and zinc, for which a concentration plant is planned.

## DEER LODGE COUNTY.

*Mine production of gold, silver, copper, and lead in Deer Lodge County, Mont., in 1921 and 1922.*

| Year. | Number of producers. | Ore. | Gold.[a] | Silver. | Copper. | Lead. | Total value. |
|---|---|---|---|---|---|---|---|
| | | *Short tons.* | | *Fine ounces.* | *Pounds.* | *Pounds.* | |
| 1921 | 6 | 26,544 | $88,040 | 135,320 | 650 | ..... | $223,444 |
| 1922 | 9 | 37,673 | 48,752 | 203,957 | 2,677 | 28,759 | 254,652 |
| Increase or decrease, 1922 | +3 | +11,129 | −39,288 | +68,637 | +2,027 | +28,759 | +31,208 |

[a] Includes small placer production.

The output of Deer Lodge County was mainly of silver ore and gold-bearing iron ore, which was used as a flux in smelting. At Anaconda, where most of the copper ore and lead-zinc ore mined in Montana was treated, the copper and zinc concentrators, copper-smelting plant, and arsenic plant were active about 10 months in 1922 but not at full capacity. The copper plant has 11 blast furnaces, 10 reverberatories, and 7 converters, but the blast furnaces have not been used extensively in recent years. The results of smelting operations are given in the report of the Anaconda Copper Mining Co. under Silver Bow County.

*Georgetown district (Southern Cross).*—Four deep mines in the Georgetown district produced 7,899 tons of ore, containing $36,234 in gold, or $4.59 a ton. The output consisted of oxidized gold-bearing iron ore shipped from the Golden Wedge, Holdfast, Oro Fino, and Short Shift mines and used as a flux at East Helena, Mont. Most of this ore was mined from the Short Shift and Oro Fino mines. The Golden Wedge was a new producer.

*Dry Gulch district.*—A little placer gold was mined from Dry Gulch, 10 miles north of Anaconda.

*Oro Fino district.*—The mining of silver ore was continued at the Champion mine, operated by the Butte Jardine Metals Mines Co. About 30,000 tons was milled by flotation, and the concentrates were shipped to Anaconda and East Helena.

*Unorganized (Blue Nellie) district.*—Several lots of rich silver-lead ore were shipped from the George mine, 12 miles northwest of Anaconda.

## FERGUS COUNTY.

*Mine production of gold and silver in Fergus County, Mont., in 1921 and 1922.*

| Year. | Number of producers. | Ore. | Gold.[a] | Silver.[a] | Total value. |
|---|---|---|---|---|---|
| | | *Short tons.* | | *Fine ounces.* | |
| 1921 | 4 | 15,118 | $80,981 | 1,758 | $82,739 |
| 1922 | 10 | 5,075 | 29,870 | 2,957 | 32,827 |
| Increase or decrease, 1922 | +6 | −10,043 | −51,111 | +1,199 | −49,912 |

[a] Includes placer production.

All the ore produced in Fergus County was siliceous, and most of it was treated by cyanidation. The ore milled had an average value of $6.03 a ton.

*Cone Butte district.*—One lot of silver ore from the Dardanelles mine was shipped to Anaconda.

*North Moccasin district (Kendall).*—Three deep mines and one placer in the North Moccasin district produced 4,843 tons of ore, $27,977 in gold, and 491 ounces of silver, valued together at $28,468. The ore had an average value of $5.87 a ton. The North Moccasin mine, 7 miles from Hilger, was operated seven months under the direction of the Barnes-King Development Co., the ore being treated in a 300-ton cyanidation plant. The printed report[2a] gives the following paragraphs:

> The North Moccasin property at Kendall was operated by the same lessees as for the preceding 15 months, the lease terminating September 23, 1922.
>
> During the year the production was 4,415 tons of an average assay value per ton of $5.09, on which the Barnes-King Development Co. received in royalties the sum of $3,329.85.
>
> So far as known, all ore of pay grade has been exhausted, and by pay grade is meant any considerable tonnage of ore assaying $3 or better per ton. The last ore mined came from the 300-foot level around the shaft, where heavy timbering and filling was necessary, and while the grade of it was nearly $7 per ton, extraction expense was still greater.

The company has done 37,289 feet of development work in the North Moccasin mine from the time operations started to the end of 1922, and 288,140 tons of ore was extracted, or 7.7 tons per linear foot of development work.

The Kendall mine was leased and operated 60 days. The production was small, and it is not likely that the property will be worked in the future.

*Warm Springs district (Giltedge).*—Five deep mines in the Warm Springs district produced 208 tons of ore, containing $1,883 in gold and 1,387 ounces of silver, valued together at $3,270, or $15.72 a ton. Nearly all the output came from the Maginnis mine, at which gold ore was treated by cyanidation. Small lots of silver ore were shipped from the Monte Cristo, Silver Queen, and Kell properties.

[2a] Barnes-King Development Co. Ann. Rept. for year ending Dec. 31, 1922.

## GRANITE COUNTY.

*Mine production of gold, silver, copper, lead, and zinc in Granite County, Mont., in 1921 and 1922.*

| Year. | Number of producers. | Ore. | Gold.[a] | Silver.[a] | Copper. | Lead. | Recoverable zinc. | Total value. |
|---|---|---|---|---|---|---|---|---|
| | | *Short tons.* | | *Fine ounces.* | *Pounds.* | *Pounds.* | *Pounds.* | |
| 1921 | 40 | 15,327 | $64,163 | 529,059 | 20,646 | 421,102 | 363,740 | $633,022 |
| 1922 | 33 | 24,265 | 69,631 | 654,289 | 29,603 | 531,485 | 1,124,355 | 821,236 |
| Increase or decrease, 1922 | −7 | +8,938 | +5,468 | +125,230 | +8,957 | +110,383 | +760,615 | +188,214 |

[a] Includes placer production.

The quantity of ore sold or treated in Granite County in 1922 increased 8,938 tons, and the value of the metal output, which was mostly silver, increased nearly 30 per cent.

*Alps district.*—A small test lot of gold ore from the Rainy Day mine was treated by amalgamation.

*Dunkleberg district.*—Several hundred tons of sulphide lead ore was shipped from the Forest Rose mine, operated by the Butte & Western Mining Co. The company planned the installation of a milling plant in the spring of 1923 to handle the sulphide ore, of which there is said to be a large quantity in reserve.

*First Chance district (Garnet).*—Four deep mines and two placers in the First Chance district produced 1,813 tons of ore, $27,374 in gold, 1,434 ounces of silver, and 468 pounds of copper, valued in all at $28,871. The ore had an average value of $15.73 a ton, and most of it was produced at the Mitchell-Mussigbrod property, where gold ore was treated in a 10-stamp mill equipped for amalgamation and concentration. Most of the gold output of the district was contained in first-class shipping ore from the Magone & Anderson property, 9 miles west of Garnet. A little placer gold was produced from the Hilltop and other claims near Bearmouth.

*Flint Creek district (Philipsburg).*—Nineteen deep mines in the Flint Creek district produced 20,788 tons of ore, containing $26,708 in gold, 642,357 ounces of silver, 25,588 pounds of copper, 421,655 pounds of lead, and 1,124,355 pounds of zinc, valued in all at $759,798, or $36.55 a ton. Most of the ore was first-class silver ore, but some of the output containing lead and zinc was milled at Anaconda. The largest producers were the Granite-Bimetallic and Philipsburg properties. Several thousand tons of siliceous silver ore was shipped from the Granite-Bimetallic mine, and about 1,000 feet of development work was done. The Philipsburg Mining Co. used its milling plant for manganese ore and shipped first-class silver ore, as well as milling ore containing lead and zinc. Other notable producers of silver ore were the Scratchall, Two Per Cent, and Trout properties. Shipments were also made from the Hoffman, Moorelight, Hope, Little Gem, Londonderry, Young America, Sanders, McKay, Old Chief, and Sweet Home properties.

*Moose Lake district.*—Rich gold ore from the Banner mine, near Philipsburg, was treated by concentration. Most of the product was shipped to the East Helena smelter.

*Rock Creek district.*—The Basin placer, near Philipsburg, was operated, and gold valued at about $7,000 was shipped to the mint at Denver, Colo.

*South Boulder district (Maxville).*—Four deep mines in the South Boulder district produced 67 tons of ore, containing $56 in gold, 3,323 ounces of silver, 1,948 pounds of copper, and 2,846 pounds of lead, valued in all at $3,799, or $56.70 a ton. The output consisted principally of siliceous silver ore from the Brooklyn mine and silver-lead ore from the Queen property.

## JEFFERSON COUNTY.

*Mine production of gold, silver, copper, lead, and zinc in Jefferson County, Mont., in 1921 and 1922.*

| Year. | Number of producers. | Ore. | Gold.[a] | Silver.[a] | Copper. | Lead. | Recoverable zinc. | Total value. |
|---|---|---|---|---|---|---|---|---|
| | | *Short tons.* | | *Fine ounces.* | *Pounds.* | *Pounds.* | *Pounds.* | |
| 1921 | 76 | 16,192 | $40,440 | 113,744 | 23,947 | 817,266 | ..... | $194,050 |
| 1922 | 56 | 64,216 | 144,564 | 175,487 | 77,124 | 577,703 | 3,797 | 362,454 |
| Increase or decrease, 1922 | −20 | +48,024 | +104,124 | +61,743 | +53,177 | −239,563 | +3,797 | +168,404 |

[a] Includes placer production.

The value of the output of Jefferson County increased nearly 87 per cent, on account of the increase in gold and silver, largely from mines in the Elkhorn district.

*Amazon district.*—Three deep mines in the Amazon district produced 174 tons of ore, containing $800 in gold, 3,340 ounces of silver, 427 pounds of copper, and 1,535 pounds of lead, valued in all at $4,282, or $24.61 a ton. Most of the output was siliceous silver ore from the Bismark mine, on Amazon Creek.

*Boulder district.*—Three deep mines in the Boulder district produced 35 tons of ore, valued at $1,194. Small lots were shipped from the Baltimore, Molly McGregor, and Sheils & Ironside properties.

*Cataract district (Basin).*—Fourteen deep mines and two placers in the Cataract district produced 1,998 tons of ore, $10,483 in gold, 27,722 ounces of silver, 45,758 pounds of copper, 51,577 pounds of lead, and 3,797 pounds of zinc, valued in all at $47,435. The ore had an average value of $23.71 a ton. About 1,000 tons of gold and silver ore was shipped from the Katy mine by lessees. Sulphide copper ore was shipped from the Crystal mine, near Basin, and oxidized lead ore from the West Rumley property. Mixed ore containing lead and zinc was shipped to East Helena and Anaconda from the Buckeye mine. Other small producers were the King Cole, Morning Glory, Comet, Grey Eagle, Silver Hill, Red Wing, Silver Trail, Solar Pearl, and Granite Butte properties. Considerable development work was done by the Jib Mining Co., which was said to have opened ore on the 400-foot level of the Katy mine in April.

*Colorado district (Wickes).*—Fourteen deep mines and one placer in the Colorado district produced 5,796 tons of ore and old slag, $14,761 in gold, 40,242 ounces of silver, 14,639 pounds of copper, and 507,184 pounds of lead, valued in all at $84,874. The ore had an average value of $14.64 a ton. The output consisted of 4,300 tons of concentrating ore, 524 tons of first-class shipping ore, 200 tons of ore treated by cyanidation, and 772 tons of old slag. Most of the ore output was mined at the Mount Washington property, operated by the Angelica Mining & Development Co. Lead ore was treated in a 50-ton mill equipped for concentration and flotation. The Gold Coin property, near Jefferson City, produced gold ore which was treated by cyanidation. Other shipments were made from the Ariadne, Blizzard, Gregory, Mayflower, Minah, Stegmiller, Alta, and Devall properties. Old slag containing silver and lead was shipped from the Dailey group, at Wickes.

*Elkhorn district.*—Ten deep mines in the Elkhorn district produced 56,173 tons of ore and old tailings, containing $117,596 in gold, 102,168 ounces of silver, 15,108 pounds of copper, and 5,269 pounds of lead, valued in all at $222,094, or $3.95 a ton. The output consisted of 31,763 tons of ore treated by cyanidation, 22,155 tons of old tailings re-treated, and 2,255 tons of crude ore smelted. The largest production of gold in the district came from the Swissmont mine, owned by the East Butte Copper Mining Co., which operated a 175-ton cyanide plant throughout the year on low-grade gold ore. The ore body is a contact deposit between limestone and diorite. The mine is opened by a vertical shaft 220 feet deep and crosscuts aggregating 1,345 feet. The printed report[2] gives the following information:

> The operations at Elkhorn have resulted in the development of a considerable body of low-grade ore. The character of the ore has, however, changed considerably from that of earlier developments, and the treatment plant is not giving entirely satisfactory results. Returns from the operation have covered the expense of exploring and developing the property but have not resulted in a profit beyond this.

The old tailings dump at Elkhorn was worked by the Western Metallurgical Co., which shipped silver bullion as well as rich silver concentrate. The tailings were treated by concentration followed by cyanidation, and the dump is said to contain 150,000 tons of material averaging about 7 ounces of silver to the ton with a little gold. The Golden Curry mine was operated by lessees, and several thousand tons of sulphide iron ore containing gold, silver, and copper was shipped to various smelting plants. Other producers were the Albion, Elkhorn Silver, Relief, Union, Bull Moose, and Woodrow mines.

*Homestake district.*—One test lot of gold ore was shipped from the Montana property, near Homestake.

*Lump Gulch district (Clancey).*—Four deep mines and one placer in the Lump Gulch district produced 21 tons of ore, $238 in gold, 1,293 ounces of silver, and 7,759 pounds of lead, valued in all at $1,958. The ore had an average value of $85.28 a ton. Small lots of sulphide lead ore were shipped from the Badger, Oregon, Little Nell, and Kokomore properties. A little placer gold was mined in Lump Gulch, near Clancey.

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[2] East Butte Copper Mining Co. Ann. Rept. for year ending Dec. 31, 1922.

*Mitchell Gulch district.*—One lot of gold ore was shipped from the Eureka property, operated by the Montana Eureka Mining Co. About 1,000 feet of drifts and upraises were cut in 1922.

## JUDITH BASIN COUNTY.

*Barker district (Hughesville).*—Six deep mines in the Barker district produced 15,090 tons of ore, containing $3,314 in gold, 94,074 ounces of silver, and 1,941,851 pounds of lead, valued in all at $204,190, or $13.53 a ton. Most of the ore, or 14,450 tons, was milled to make 2,637 tons of concentrates, and the remainder, 640 tons, was shipped as first-class ore. The Wright & Edwards property, the largest producer in the district, was operated by the Block P. Mining Co. About 1,000 tons of ore a month was treated by concentration, and both crude ore and concentrates were shipped to the East Helena smelter. Several shipments of first-class lead ore were made from the Last Chance mine, and small lots of ore were shipped from the August, Lampson, Liberty, and Silver Bell properties.

*Running Wolf Creek district.*—The Mountainside property, near Stanford, produced a small lot of lead ore which was smelted at East Helena.

## LEWIS AND CLARK COUNTY.

*Mine production of gold, silver, copper, and lead in Lewis and Clark County, Mont., in 1921 and 1922.*

| Year. | Number of producers. | Ore. | Gold. | Silver. | Copper. | Lead. | Total value. |
|---|---|---|---|---|---|---|---|
| | | *Short tons.* | | *Fine ounces.* | *Pounds.* | *Pounds.* | |
| Placers: | | | | | | | |
| 1921 | 17 | ..... | $4,806 | 65 | ..... | ..... | $4,871 |
| 1922 | 12 | ..... | 3,984 | 28 | ..... | ..... | 4,012 |
| Deep mines: | | | | | | | |
| 1921 | 36 | 49,864 | 371,779 | 44,619 | 5,973 | 434,788 | 436,735 |
| 1922 | 38 | 28,175 | 251,295 | 30,597 | 9,430 | 90,023 | 288,116 |
| Increase or decrease, 1922 | −3 | −21,689 | −121,306 | −14,059 | +3,457 | −344,765 | −149,478 |

The ore mined in Lewis and Clark County decreased more than 43 per cent in 1922, and most of it was treated in milling plants by cyanidation. The quantity and value of all metals except copper decreased. Smelting of lead ore and siliceous ore at an increased rate was continued at East Helena throughout the year. Custom ore was received from Montana, Idaho, Washington, and British Columbia, and the equipment was increased by the addition of blast furnaces and other machinery from the dismantled plant at Northport, Wash.

*Bald Butte district (Marysville).*—The output of the Bald Butte district consisted of oxidized silver-lead ore from the Carbonate mine, at the head of American Gulch, and gold and silver bullion from the cyanidation of old tailings at the Bald Butte property.

*Dry Gulch district.*—Six placers and one deep mine in the Dry Gulch district produced 35 tons of ore, $2,238 in gold and 16 ounces of silver. The placer output came from the Blue Jay, Jim, and other claims near York.

*Grass Valley district.*—Five deep mines in the Grass Valley district produced 145 tons of ore, containing $267 in gold, 6,429 ounces of silver, and 8,479 pounds of lead, valued in all at $7,162, or $49.39 a ton. The output consisted of oxidized lead ore from the Carbonate Hill property and silver ore from the Liberty Bell, Nora Darling, Gray Eagle, and New Stake claims.

*Greenhorn district.*—The North Fork placer produced gold from bar gravel by sluicing. A small mill was installed at the Kathleen property to treat gold ore, and one lot of lead ore was shipped from the Red Bird property.

*Heddleston district.*—Two lots of lead ore were shipped from the Anaconda and Sterling properties, near Silver. The Sterling mine was not active in 1922, but a flotation plant is planned.

*Helena district.*—Two deep mines and two placers in the Helena district produced 6 tons of ore, $352 in gold, 53 ounces of silver, and 896 pounds of lead, valued in all at $454. A little placer gold was mined from the Humboldt claim, on Grizzly Gulch.

*Lincoln district.*—Placer gold was mined by sluicing at the Harvey and Survey 271 properties.

*Ottawa district (Marysville).*—Ten deep mines in the Ottawa district produced 27,303 tons of ore and old tailings, containing $247,060 in gold, 14,369 ounces of silver, 565 pounds of copper, and 15,601 pounds of lead, valued in all at $262,363, or $9.61 a ton. Most of the ore, or 25,413 tons, was treated in cyanidation or amalgamation plants, and 665 tons was shipped to smelters. The Barnes-King Development Co. operated the Shannon mine and treated a large quantity of gold ore in the 150-ton cyanidation plant. The ore reserves consist of about 10,000 tons of $12 ore. The company's report [3] says:

> The Gloster mill treated 25,411 dry tons of ore from the Shannon mine, which was 10,975 tons less than for the preceding year. Naturally this much smaller tonnage was milled at a greater cost per ton than for 1921.
>
> Milling cost per ton of ore, coarse crushing not included, was $2.49; the average assay value per ton of ore was $9.03; and mint returns were $218,577. * * *
>
> The most important development was the sinking of a winze 100 feet below the 600 or bottom level and the work done on the 700 level. The sill was opened up for a lateral distance of 293 feet east of the winze, where good ore was found the last of the year in a north crosscut with a length of 33 feet in strike. * * * So far as opened this bottom level has been disappointing. * * *
>
> Since operations on the Shannon mine began 197,969 tons of ore has been extracted and 19,596 feet of development work done.

Several hundred tons of high-grade gold ore was shipped from the Drumlummon mine, owned by the St. Louis Mining & Milling Co. Old tailings containing gold and silver from the Drumlummon and Eck properties were treated by cyanidation. Other producers were the Bald Mountain, North Star, and Calumet properties.

*Scratch Gravel district.*—Six deep mines in the Scratch Gravel district produced 96 tons of ore, containing $1,150 in gold, 3,266 ounces of silver, 457 pounds of copper, and 12,230 pounds of lead, valued in all at $5,151, or $53.66 a ton. Several lots of oxidized lead ore were shipped from the Bonanza, Fairview, and Silver Coin mines, and one lot of gold ore from the North Star property.

*Seven Mile district.*—Several lots of lead ore were shipped from the Saginaw and Silver King properties.

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[3] Barnes-King Development Co. Ann. Rept. for year ending Dec. 31, 1922.

*Unionville district.*—Material in the vicinity of the Whitlatch property was handled by sluicing operations, and gold bullion was shipped to the assay office at Helena.

*Vaughn district (Rimini).*—Five deep mines in the Vaughn district produced 77 tons of ore, containing $597 in gold, 1,809 ounces of silver, 6 pounds of copper, and 19,165 pounds of lead, valued in all at $3,461, or $44.95 a ton. Several lots of sulphide lead ore containing considerable silver were shipped from the Anna May and Broadway properties. One lot of lead ore was shipped from the Valley Forge mine, formerly a large producer.

*Wolf Creek district.*—The New Era group, 5 miles from Wolf Creek, produced one shipment of copper ore.

## LINCOLN COUNTY.

*Libby district.*—Lead ore from the Lukens Hazel mine, near Libby, was treated in a 200-ton concentration-flotation plant. The mine was operated the entire year, and lead concentrate was shipped to Bradley, Idaho, and East Helena, Mont. The mine is opened by an inclined shaft 240 feet deep, a drift 1,500 feet long, and a tunnel 1,200 feet long.

*Sylvanite district.*—A test shipment of lead ore containing considerable gold was made from the Black Diamond property.

*Troy or Callahan Creek district.*—The Snow Storm Mines Co. operated its concentration-flotation plant and shipped several thousand tons of high-grade lead concentrate to Bradley, Idaho, and East Helena, Mont. At the end of the year the company was reorganized and financial backing procured to continue the development of the mine. An interesting article [4] which gave the history, development, equipment, and production of the mine appeared in March. The vein is described as a true fissure standing nearly vertical in the Prichard formation. It is developed by seven tunnels to a depth of 900 feet and is opened horizontally for a distance of 2,500 feet. Since 1917 the mine is said to have produced the following metals from lead-zinc ore: Gold, 1,930 ounces; silver, 528,198 ounces; lead, 21,002,569 pounds; and zinc, 5,277,168 pounds.

## MADISON COUNTY.

*Mine production of gold, silver, copper, and lead in Madison County, Mont., in 1921 and 1922.*

| Year. | Number of producers. | Ore. | Gold. | Silver. | Copper. | Lead. | Total value. |
|---|---|---|---|---|---|---|---|
| | | *Short tons.* | | *Fine ounces.* | *Pounds.* | *Pounds.* | |
| Placers: | | | | | | | |
| 1921 | 5 | ..... | $191,121 | 1,354 | ..... | ..... | $192,475 |
| 1922 | 6 | ..... | 38,577 | 393 | ..... | ..... | 38,970 |
| Deep mines: | | | | | | | |
| 1921 | 57 | 16,241 | 244,342 | 45,469 | 30,729 | 540,506 | 318,098 |
| 1922 | 49 | 21,543 | 178,302 | 44,608 | 30,849 | 372,658 | 247,571 |
| Increase or decrease, 1922 | −7 | +5,302 | −218,584 | −1,822 | +120 | −167,848 | −224,032 |

[4] Snow Storm Silver-Lead Co.: Min. Truth, vol. 8, Mar. 3, 1923.

A decided decrease in the output of gold in Madison County was recorded in 1922 and was due in part to the marked decrease in dredge operations.

*Alder Gulch district* (*Virginia City*).—Seven deep mines and four placers in the Alder Gulch district produced 13,150 tons of ore, $77,699 in gold, 27,586 ounces of silver, 4,385 pounds of copper, and 9,229 pounds of lead, valued in all at $106,385. The ore had an average value of $5.20 a ton. The placer output consisted of gold valued at $37,570 and 381 ounces of silver. Most of the placer gold came from the dredge operations of the Conrey Placer Mining Co. The company operated one dredge two months and treated 545,400 cubic yards of material, after which it sold all the dredging equipment. The company has been a large producer of gold since 1902, and the output was especially large in 1914. Most of the ore output was that of the High Up mine, operated by the Greenback Mining Co., and the Marietta mine, worked by the Barton Gulch Mining Co. Ore of both mines was concentrated, and the product, rich in gold and silver, was shipped to East Helena and Anaconda. About 1,000 tons of lead ore containing considerable gold was shipped from the Florence mine, and a good grade of silver ore was shipped from the U. S. Grant property. Smaller producers were the Alameda, Cornucopia, Silver Bow, and Pacific properties.

*Lower Hot Springs district* (*Norris*).—The output of the Lower Hot Springs district consisted of small lots of silver ore from the Silver Lining and Morning Star mines and one lot of gold ore from the Surprise property.

*McCarthy Mountains district.*—The Hidden Treasure mine produced one shipment of exceedingly rich gold ore and the Polly Jane property one lot of silver-lead ore.

*Mineral Hill district* (*Pony*).—The output of the Mineral Hill district was practically all gold ore from the Boss Tweed mine, near Pony. The ore was treated by amalgamation and concentration in a 10-stamp mill. The mine is opened by a tunnel 1,000 feet long.

*Rabbit district* (*Rochester*).—Six deep mines in the Rabbit district produced 371 tons of ore, containing $14,313 in gold, 2,079 ounces of silver, 140 pounds of copper, and 26,189 pounds of lead, valued in all at $17,851, or $48.12 a ton. A large part of the production was rich gold ore shipped from the Pete & Joe property, near Twin Bridges. Small lots of lead ore were shipped from the Mountain View and other claims by lessees.

*Ramshorn district* (*Laurin*).—The output of the Ramshorn district consisted of gold and silver ore from the Ellajay property, silver ore from the Silver Point mine, and a little placer gold from Ramshorn and Bivens gulches.

*Sheridan district.*—Ore from the Tamarack group was treated by amalgamation and concentration. The mine is opened by a vertical shaft 160 feet deep, 800 feet of drifts, and a tunnel 1,200 feet long. During the year 300 feet of development work was done. One lot of rich gold ore was shipped from the Emma B. mine, operated by the Smuggler Mining Co.

*Silver Star district.*—Eight deep mines in the Silver Star district produced 410 tons of ore, containing $23,073 in gold, 2,009 ounces of silver, 738 pounds of copper, and 9,824 pounds of lead, valued in all at $25,722, or $62.74 a ton. The largest production was several

hundred tons of gold ore from the Strawn group, operated by the Barnes-King Development Co. The lease, however, was not profitable and was relinquished November 1, 1922. Several shipments of gold ore were made from the Hudson, Fool Hen, Edgerton, and Broadway properties. The Wheal Clifford property produced one lot of silver ore, and the Emma mine one lot of lead ore.

*Summit district* (*Virginia City*).—A little gold ore from the Highland Chief and Mountain Flower mines was treated by amalgamation and concentration. The tailings were held for future treatment by cyanidation.

*Tidal Wave district* (*Twin Bridges*).—Ten deep mines in the Tidal Wave district produced 175 tons of ore, containing $3,931 in gold, 2,653 ounces of silver, 5,063 pounds of copper, and 7,982 pounds of lead, valued in all at $7,707, or $44.04 a ton. Most of the output was gold ore from the Lottie mine. The remainder of the production consisted of small lots of ore from the Empire State, High Ridge, Keynote, Lucky Strike, Silver Coin, Texas, Rochester, and Blue Bird mines.

*Upper Hot Springs district.*—Three deep mines in the Upper Hot Springs district produced 1,124 tons of ore, containing $11,886 in gold and 1,042 ounces of silver, valued together at $12,928, or $11.50 a ton. The Revenue mines near Norris were idle most of the year, but bullion from the operation of the cyanide plant was marketed in January. Small test shipments of gold ore were made from the Bull Moose and Balmoral properties.

*Washington district.*—Most of the output of the Washington district was gold ore treated by amalgamation, concentration, and cyanidation by the Missouri Mining Co. The ore body is a blanket deposit opened by tunnels and winzes, and the mine was operated vigorously during the summer months. One lot of high-grade gold ore was shipped from the Lehigh mine, near Norris.

*Wisconsin Creek district.*—A test lot of gold ore from the Sparrow claim was shipped to the Pittsmont smelter at Butte.

### MEAGHER COUNTY.

*Beaver Creek district.*—A small placer output was made from the Klondyke and other claims on Beaver Creek, 7 miles from Watson.

*Copperopolis district.*—One lot of copper ore was shipped from the Copperopolis mine, near Martinsdale.

*Little Belt district.*—One lot of rich gold ore was shipped from the Jack Pine mine, near Canton.

*Musselshell district.*—A test shipment of gold ore was made from the Park property, and ore containing gold and silver was shipped from the Bourbon lode.

### MINERAL COUNTY.

*Cedar Creek district* (*Iron Mountain, Quartz*).—Ten placers in the Cedar Creek district produced gold valued at $5,410 and 9 ounces of silver. The largest producers were the Windfall, C. B. & Q., Meadow Creek, and Cedar Creek properties.

*Iron Mountain district.*—The Mineral Development Co. operated the Iron Mountain mine, north of Superior, and shipped several hundred tons of silver-lead ore.

*St. Regis district.*—The Amazon Dixie Mining Co. is said to have opened much low-grade ore at depth. The shaft is 1,500 feet deep.

### MISSOULA COUNTY.

*Coloma district.*—The output of the Coloma district consisted of a little placer gold from the Davey property and gold ore from the Dandy mine, part of which was shipped and part amalgamated.

*Ninemile district.*—Three placers in the Ninemile district produced gold valued at $364. The output came from the Boyd, Chrysalis, and Marion Creek placers, operated by hydraulicking.

*Woodmans Creek district.*—One small lot of copper ore was shipped from the Lawyers Combination property, near Lolo.

*Unorganized district (Nimrod).*—The Katy mine, near Nimrod, produced one car of silver-lead ore.

### PARK COUNTY.

*Emigrant Creek district.*—Three placer mines in the Emigrant Creek district produced gold valued at $367 and 3 ounces of silver. The output came from the Wolverine, Get There Jimmy, and other claims, 8 miles from Emigrant.

*New World district (Cooke).*—The Irma and Morning Star mines produced several lots of sulphide lead ore containing silver. The Irma mine is said to have about 1,800 tons of ore in reserve.

*Sheepeater district (Jardine).*—The Jardine mine was operated the entire year, and nearly 37,000 tons of gold ore was treated by amalgamation and concentration. The mine has a large tonnage of ore in reserve, and the principal ore mineral is arsenopyrite containing gold. The mine is equipped with a 40-stamp amalgamation and concentration plant, and three flotation machines were added during the year. Early in 1923 an arsenic plant was installed so as to roast the concentrate, save the arsenic, and ship the gold-bearing calcine for smelting.

### PHILLIPS COUNTY.

*Little Rockies district.*—The mines of the Little Rockies district were large producers of gold prior to 1918, when they were forced to close on account of high costs. In July, 1922, operations were resumed by the Ruby Gulch Mining Co., and a large quantity of low-grade gold ore was treated in a 600-ton cyanide plant. The property is said to have about 232,000 tons of ore, which contains gold and silver valued at about $2.50 a ton. The mine was operated under difficulty on account of labor shortage during the summer and fall. An article [5] on the occurrence of the ore and the geology of these deposits was published in 1908.

### POWELL COUNTY.

*Big Blackfoot district.*—The Gold Dust placer, on Ogden Mountain, 7 miles from Helmville, produced considerable gold by hydraulic methods.

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[5] Emmons, W. H., Gold deposits of the Little Rocky Mountains, Mont.: U. S. Geol. Survey Bull. 340, pp. 96–116, 1908.

*Nigger Hill district.*—Four deep mines in the Nigger Hill district produced 437 tons of ore, containing $12,930 in gold, 5,264 ounces of silver, 208 pounds of copper, and 54,806 pounds of lead, valued in all at $21,236, or $48.59 a ton. Most of the output was mined from the Big Dick property, operated under lease. Several hundred tons of lead ore containing considerable gold and silver was shipped to East Helena. Other shipments were made from the Geraldine and Carbonate Boy mines.

*Ontario district (Elliston).*—Five deep mines in the Ontario district produced 133 tons of ore, containing $4,161 in gold, 2,734 ounces of silver, 155 pounds of copper, and 46,801 pounds of lead, valued in all at $9,490, or $71.35 a ton. The output consisted of oxidized lead ore containing considerable gold shipped from the Black Jack, Charter Oak, Democrat, and Carbonate King mines.

*Ophir district (Finn).*—A little placer gold was mined from the Carpenter Bar property, near Avon.

*Pioneer district (Gold Creek).*—Five placers in the Pioneer district produced $2,556 in gold and 18 ounces of silver. The Friday, Orofino, and Pioneer placers, on Gold Creek, sold considerable gold through storekeepers at Deer Lodge.

*Washington Gulch district.*—The Fontana placer, in Washington Gulch, produced placer gold by sluicing.

*Zozell district.*—Three deep mines in the Zozell district produced 150 tons of ore, containing $3,150 in gold, 6,342 ounces of silver, and 15,415 pounds of lead, valued in all at $10,340, or $68.93 a ton. The output consisted of several lots of silver ore from the Blue Eyed Maggie mine and one car of oxidized lead ore from the Emery Consolidated property, 9 miles east of Deer Lodge.

*Unorganized district.*—The North Pole property, 7 miles southeast of Elliston, produced one small lot of silver ore.

### RAVALLI COUNTY.

Property in the Hughes Creek district, 45 miles south of Darby, formerly a large producer of placer gold, was practically idle in 1922. A little placer bullion was purchased by storekeepers.

### SANDERS COUNTY.

*Perma district.*—The Chilson property, near Perma, produced one lot of copper ore.

*Revais Creek district.*—The Dixon mine was operated a few days and produced one lot of copper ore.

*Thompson River district.*—Copper ore containing considerable silver was shipped from the Silver King and Copper King properties.

## SILVER BOW COUNTY.

*Mine production of gold, silver, copper, lead, and zinc in Silver Bow County, Mont., in 1921 and 1922.*

| Year. | Number of producers. | Ore. | Gold.[a] | Silver.[a] | Copper. | Lead. | Recoverable zinc. | Total value. |
|---|---|---|---|---|---|---|---|---|
| | | *Short tons.* | | *Fine ounces.* | *Pounds.* | *Pounds.* | *Pounds.* | |
| 1921 | 61 | 1,141,013 | $283,502 | 4,983,972 | 47,957,949 | 13,241,497 | 22,901,059 | $13,194,969 |
| 1922 | 56 | 4,010,759 | 543,746 | 10,395,880 | 165,374,403 | 20,139,969 | 117,941,666 | 41,095,544 |
| Increase or decrease, 1922. | −5 | +2,869,746 | +260,244 | +5,411,908 | +117,416,454 | +6,898,472 | +95,040,607 | +27,900,575 |

[a] Includes placer production.

Most of the output of Silver Bow County in 1922 was produced by six companies. As the mines at Butte resumed operations early in the year, the output was decidedly greater than that of 1921. The largest part of the ore produced was concentrated at milling plants at Butte and Anaconda. The product consisted of copper concentrates, zinc concentrates, lead-zinc concentrates, lead concentrates, and siliceous concentrates, valued in all at $36,664,360, or $35.96 a ton. The crude smelting ore had an average value of $18.98 a ton. No ore was treated by amalgamation or cyanidation, but 1,000,569 tons of old tailings was re-treated by concentration, 26,309 tons of slag was smelted, and 5,010 tons of ore was treated by chlorination. Of the total output of ore 81 per cent was classified as copper material.

*Divide Creek district* (*Melrose*).—Four deep mines in the Divide Creek district produced 54 tons of ore, containing $354 in gold, 1,045 ounces of silver, and 513 pounds of lead, valued in all at $1,427, or $26.43 a ton. Small lots of silver ore were shipped from the Gold Dust, Gray Rock, and Pandora properties, and one lot of gold ore came from the Garland mine.

*German Gulch district.*—Placer bullion, containing gold valued at $2,303 and 19 ounces of silver, was mined by several operators in the German Gulch district. The Beal placer was the largest producer.

*Lost Child district.*—Placer gold was mined from the Portland and Jimmie placers, on Yankee Doodle Creek.

*Summit Valley or Butte district.*—Forty-seven deep mines in the Butte district produced 4,010,705 tons of ore and old tailings, containing $540,936 in gold, 10,394,811 ounces of silver, 165,374,403 pounds of copper, 20,139,456 pounds of lead, and 117,941,666 pounds of recoverable zinc, valued in all at $41,091,636, or $10.25 a ton. Most of the ore, or 2,833,964 tons, was reduced to 1,019,492 tons of concentrates, 144,853 tons was shipped directly to smelters, and the remainder was ore chlorinated, old tailings re-treated, and old slag re-smelted. In 1921, when the large mines of the district were closed about nine months of the year, the output was valued at $13,187,215.

From the beginning of activities in 1882 to the end of 1922 Silver Bow County, of which this district covers the largest part, has produced gold, silver, copper, lead, and zinc valued at

$1,735,460,682, as follows: Gold, $32,346,006; silver, $276,965,724; copper, $1,274,809,968; lead, $8,423,485; and zinc, $142,915,499. The production of zinc began in 1905. The values given above represent 1,564,738 ounces of gold, 376,104,727 ounces of silver, 8,152,406,826 pounds of copper, 138,194,808 pounds of lead, and 1,607,869,611 pounds of recoverable zinc.

The mines of the Anaconda Copper Mining Co.[6] produced 1,983,106 tons of ore and 7,572 tons of precipitates, a total of 1,990,678 tons, in 1922, against 421,416 tons in 1921. The copper-reduction works treated for all companies 2,224,709 tons of ore at Anaconda. No copper ores were treated at Great Falls, but a small quantity of copper concentrates from Anaconda was used for fluxing the zinc plant residues. Of the material treated at Anaconda 1,878,162 tons of ore was produced by company mines, 322,918 tons was either purchased from or treated for other companies, and 23,629 tons came from the old plants at Anaconda and Butte. The Anaconda works produced 157,346,016 pounds of fine copper, 7,367,859 ounces of silver, and 26,026.11 ounces of gold, and a large part of this output came from the mines of the Anaconda Co. The electrolytic copper refinery at Great Falls produced 140,901,359 pounds of cathodes, most of which were melted into shapes at Great Falls. The total production of copper rods for the year was 68,403,742 pounds. Of this quantity, 23,765,134 pounds was manufactured into wire, of which 10,598,165 pounds was made into strand. The copper-leaching plant at Anaconda remained closed throughout the year. The zinc plants at Anaconda and Great Falls treated 236,323 tons of ore and other zinciferous material, of which 93,241 tons was produced by mines of the Anaconda Co., 633 tons of material was from the old plants at Butte, and 142,449 tons of ore and concentrates was purchased from other companies. The plant at Great Falls produced 113,475,088 pounds of electrolytic zinc, 5,604,684 pounds of zinc in dross, and residue which contained 15,211,699 pounds of lead, 1,937,696 pounds of copper, 3,373,386 ounces of silver, and 5,673.90 ounces of gold. No dividends were paid in 1922 by the Anaconda Co., but the net income for the year was $3,530,877, which, added to the balance at the end of 1921, gives a surplus of $71,284,784. Unfortunately no statement was given regarding the development work and the ore reserves of the Butte mines. The company report continues:

> The year 1922 was one of unusual importance to the copper industry as a whole. The suspension of operations by nearly all of the important American producers in 1921, forced by the inability of the consumptive demand to take the current production of copper and to also absorb the remainder of war stocks of both virgin metal and scrap held by the Allied governments, brought about the necessary readjustment of the industry. A decrease of about 400,000,000 pounds in stocks held by the producers, in addition to a marked decrease in outside stocks, made it possible to resume operations in 1922. By the end of the first quarter practically all of the American copper mines had resumed operating, and production continued thereafter throughout the year. * * *
>
> The present price of copper * * * is high only by comparison with the recent very low price. Copper is selling relatively at less than any basic commodity. The average cost per pound to the principal producers in 1913 was 9.9 cents, while the average selling price for that year was 15.7 cents, indicating an average profit of 5.8 cents—a margin normally considered as representing only a fair return. The average cost of copper produced in the United States in 1921 was 14.34 cents, while the average

[6] Anaconda Copper Mining Co. Ann. Rept. for year ending Dec. 31, 1922.

market price was only 12.7 cents per pound, an average loss of 1.64 cents per pound. In order to yield a normal profit for the industry, as measured by pre-war years, copper should to-day be selling at more than 20 cents per pound.

The most gratifying increase in the operations of your company has come in the remarkable growth of the business of the American Brass Co.

From the North Butte property[7] 172,749 dry tons of ore and precipitates was treated at the smelter at Anaconda. Of the ore, 1,126 tons, or 0.65 per cent, was first class; 162,898 tons, or 94.31 per cent, was second class; and 8,713 tons, or 5.04 per cent, was third class. The production was 9,504,389 pounds of fine copper, 308,681 ounces of silver, and 568.04 ounces of gold. The report continues as follows:

There was no production during the first five months of the year. Mining of ore was resumed on June 1 and continued until the end of the year on a scale commensurate with the condition of the copper metal market and local supply of labor. This followed the policy of copper-mining companies generally, nearly all of which had resumed earlier.

Development work was carried on continuously, although on a more curtailed basis than in previous years. A total of 8,288 feet was driven, as compared with 19,100 feet driven in 1920, the last previous year of full operation. * * * The grade of ore developed was excellent, especially in the deeper levels, although the average width was narrower than on the levels above.

In considering the results of operation it must be remembered that the entire production was made in seven months, which carried twelve months overhead, and that wages were increased in September 50 cents per day for all occupations. There has been in the Butte district, as in most western mining districts, an acute shortage of skilled miners, but the management has endeavored by education and careful supervision to train men for the work and promote operating efficiency in every way possible.

During the year the stocks of copper metal were gradually reduced, and the year closed with no more surplus than exists in ordinary times and which is necessary to maintain suitable price stabilization.

The income was $1,772,004, the cost 15.22 cents per pound of copper, and the profit $9,094.

The East Butte Copper Mining Co.[8] operated the 500-ton copper smelter and 1,000-ton concentration-flotation plant east of Butte, but the output was only about 65 per cent of that of a normal year. The mill and smelter treated 97,202 tons of company ore and 88,065 tons of custom ore, producing 875 ounces of gold, 542,650 ounces of silver, and 12,347,178 pounds of copper, a decrease in the copper output of more than 16 per cent from that of 1921. The gross value of the metals shipped was $2,362,296, including that of 5,692 ounces of gold from the Swissmont property. No dividends were paid in 1922. The price received for copper was 13.52 cents a pound, and the cost of production was 14.73 cents a pound. The report continues:

A study of operations for the years 1920 and 1921 indicates that the very satisfactory results achieved in the face of conditions then existing are traceable in a large measure to high efficiency made possible by labor conditions during these years. This improved efficiency influenced not only the amount of labor performed but equally the character of results in the sorting of ores. During 1922 conditions have been reversed; unemployment has given way to a shortage of labor, and efficiency has been reduced correspondingly. * * *

A second important cause contributing to unfavorable results is traceable to severe curtailment of mining operations and corresponding extension of exploratory and development operations. Production for the year was 101,000 tons, the lowest of any year since 1914 with the exception of 1921. Development expenditures for the year in turn were $197,000 as compared with $154,000 for 1921, $128,000 for 1920, and $88,000 for 1919. Of the amount above given for 1922, $70,000 was expended in sink-

[7] North Butte Mining Co. Ann. Rept. for year ending Dec. 31, 1922.
[8] East Butte Copper Mining Co. Ann. Rept. for year ending Dec. 31, 1922.

ing the new shaft from the eighteenth to twenty-fourth levels, a distance of 600 feet. This is to be the main working shaft of the property. The development work for the year in addition to shaft sinking consisted of 5,075 feet of drifts and crosscuts and 1,089 feet of raises.

Work described in the foregoing paragraph resulted in developing considerable extension to known ore bodies on lower levels and in opening up for advantageous mining an important ore body on the 800 level. * * * Development for the year places in sight a tonnage of ore somewhat in excess of that removed during the year. * * *

In addition to work on lower levels looking toward enlargement and extension of known ore bodies, the 2,000-foot level is being opened with a view to cutting at this depth ore bodies that have been opened on the 1,800-foot level. The work of connecting the new working shaft with the various levels and equipping this shaft for operation has gone steadily forward, and this has been a considerable factor in the year's expenditures. Completion of this shaft has very greatly improved ventilation and working conditions, and when in full operation it will effect a considerable economy in operation in addition to greatly facilitating development of deeper levels.

The Davis-Daly Copper Co. produced a large quantity of gold, silver, copper, lead, and zinc from the Colorado and Hibernia mines, though mining operations at the Colorado mine were not resumed until June 1. The Hibernia mine, opened to a depth of 750 feet, produced silver ore smelted at Anaconda and lead-zinc ore milled at Butte and roasted and leached at Black Eagle. Copper ore from the Colorado mine, which has a shaft 2,800 feet deep, was milled or smelted by the East Butte Copper Co. at Butte. The company published no report for the entire calendar year, but the following information [9] was given for the last six months:

The period covered by this report has been an eventful one. Mining operations, which had been suspended during the fall of 1921, were resumed about June 1, 1922. Equipment and surface conditions were greatly improved during the shutdown, which enabled the company to increase production as fast as labor supply and efficiency warranted, with the result that production at the Colorado has steadily increased to an average of 800 to 900 tons of ore per day. Production at the Hibernia decreased somewhat during the latter part of the year.

An important event in the period was the bringing of the suit by the Anaconda Copper Mining Co. against the Davis-Daly Copper Co. and the cross action brought by your company against the Anaconda Copper Mining Co. in the United States district court for the district of Montana, to try out the question of the apex of the veins heretofore operated by your company and of the right of the Anaconda Co. to operate within the vertical boundaries of certain territory owned by your company. * * *

Our engineers state that the veins in question from which the company has taken its ore are of the northwest and southeast vein system, that they cross the east-west veins of the Anaconda Co., that they are of a different age of mineralization, are separate and distinct veins and do not apex within the claims owned by the Anaconda Co. * * *

A very advantageous contract, extending over a period of years, for the treatment of our ores, was concluded with the East Butte Copper Mining Co. * * *

Tonnage for the six months from the Colorado mine amounted to 91,206 tons, producing 7,035,456 pounds of copper and 355,660 ounces of silver. Ore hoisted from the Hibernia mine amounted to 28,930 tons, producing 366,411 ounces of silver. The shipments during the month of December were the largest in the history of the company. * * *

The receipts were $883,762 and disbursements $552,391.

After being idle more than a year, the Butte & Superior Mining Co. began shipping zinc concentrate to Great Falls in January and after gradually increasing the output operated profitably during the last six months of the year, according to the company's quarterly reports. The property was the largest zinc producer in Montana and was again operating its 1,000-ton flotation plant at capacity

[9] Davis-Daly Copper Co. Rept. for six months ending Dec. 31, 1922.

in the fourth quarter. A large body of copper ore was developed during the year and several hundred tons of ore shipped as a test. The company [10] received $2,902,633 from the sale of concentrates in 1922. The cost of mining was $1,806,414 and milling $778,505, leaving an operating profit of $317,714. After various charges were made for depreciation, shutdown expense, litigation, and taxes, the net loss, exclusive of a depletion charge, was $289,850. The distribution to stockholders was $145,099 and the surplus $2,210,921. The report continues:

The estimated developed zinc ore reserves as at December 31, 1922, amounted to 507,950 tons, as compared with 484,507 tons at December 31, 1921. In addition to this tonnage there is a fully blocked reserve of some 353,000 tons of lower-grade ore, at least a portion of which can be handled profitably at the present favorable prices for zinc.

The zinc metal market showed a persistent improvement throughout the year both as to demand and price. The East St. Louis quotation, which for January, 1922, was 4.56 cents per pound, steadily advanced to 7 cents at the close of the year. * * *

Development of the copper ore encountered in 1921 was continued, and the vein has been opened up on six levels between the 1,900 and 2,600, or for a distance on its dip of over 700 feet. These developments have not yet reached a state either as to extent or detail such as to permit a technical calculation of definite ore reserves, but as good an estimate as can be made at this time shows something closely approximating 200,000 tons of copper ore averaging about 5 per cent copper and 6.5 ounces silver per ton. * * *

Actual mining of this copper ore was started shortly after the first of the year 1923 at a rate of 100 tons per day, and facilities are now being provided looking to an output of from 300 to 500 tons per day before the end of the current year. * * *

As stated in the report covering operations for the second quarter of the year, the flotation-process litigation in which your company was involved has been satisfactorily settled and terminated out of court, and your company is now a licensee under the patents of Mineral Separation North American Corporation. * * *

Development work during the year consisted of 13,353 feet of drifting and crosscutting, 3,507 feet of raising, 234 feet of station cutting and shaft sinking, or a total of 17,094 feet. Diamond drilling amounted to 947 feet. * * *

The following tabulation shows the total and average metals contained in ores mined and milled during the year and the total and average contents of all metals in zinc concentrates produced:

*Crude ore treated and concentrates produced at Butte-Superior mill in 1922.*

| Ore and product. | Quantity. | Gold. | | Silver. | |
|---|---|---|---|---|---|
| | | Total content. | Average per ton. | Total content. | Average per ton. |
| | *Short tons.* | *Ounces.* | *Ounces.* | *Ounces.* | *Ounces.* |
| Crude ore milled | 315,727 | 2,597.235 | 0.0082 | 1,625,854 | 5.150 |
| Zinc concentrates | 76,616 | 1,924.286 | .0251 | 1,398,914 | 18.259 |

| Ore and product. | Copper. | | Lead. | | Zinc. | |
|---|---|---|---|---|---|---|
| | Total content. | Average per ton. | Total content. | Average per ton. | Total content. | Average per ton. |
| | *Pounds.* | *Per cent.* | *Pounds.* | *Per cent.* | *Pounds.* | *Per cent.* |
| Crude ore milled | 920,368 | 0.146 | 7,280,717 | 1.153 | 92,032,419 | 14.575 |
| Zinc concentrates | 698,895 | .456 | 6,504,841 | 4.245 | 83,925,667 | 54.770 |

[10] Butte & Superior Mining Co. Eleventh Ann. Rept., for year ending Dec. 31, 1922.

The Anselmo mine was operated continuously and produced copper ore and zinc ore, both of which were milled at Anaconda. The Butte & Duluth mine, east of Butte, was practically idle in 1922, but a few shipments of copper ore were sent to Anaconda. The Emma and Ophir properties, owned by the Butte Copper & Zinc Co., were operated by the Anaconda Copper Mining Co. Lead-zinc ore was milled at Anaconda and was further treated in the electrolytic plant at Great Falls. Notes from the company's report [11] follow:

Owing to the depressed condition of the metal market and the consequent low prices for zinc and lead, the properties of your company were not in operation during the greater part of the year 1922. Work was, however, resumed in August and since that time has gone on steadily, with an average production of about 200 tons of zinc ore per day. * * *

The large ore reserves on the ninth level have not been worked as yet, some of the stopes showing large bodies of high-grade ore.

There is a considerable tonnage of manganese ore exposed and ready for shipment in the mine, but the prices thus far offered for such ores would not guarantee a sufficient profit to warrant the extraction of the same. * * *

The results of development work carried on during the year have been quite satisfactory, and early in the month of December in the winze which was sunk from the 1,000-foot level, at a depth of 70 feet, a vein was encountered showing several feet of medium-grade ore carrying a zinc value of 13 per cent; and in addition to this 2½ feet of high-grade ore carrying values of 21 per cent in zinc, 38 ounces in silver, and 8 per cent lead.

The company received $58,936 for 29,885 tons of ore; the net income was $22,847, and the surplus $808,348.

The Elm Orlu mine was operated the entire year and produced a large quantity of zinc ore, lead-zinc ore, and siliceous silver ore. Most of the output was treated in the Timber Butte mill, south of Butte, which was operated as a custom plant. Concentrates were shipped to East Helena and Great Falls. The Elm Orlu mine is opened to a depth of 2,640 feet by shaft and has more than 11,000 feet of crosscuts, drifts, and raises. The company was a notable producer of both silver and zinc and in October made a contract with the Anaconda Copper Mining Co. for its zinc concentrate.

Several thousand tons of silver ore containing gold was shipped by the Garfield & Salvador Mining Co. The Crystal Copper Co. operated the Goldsmith mine and shipped a large quantity of silver ore. The mine is opened by a vertical shaft 600 feet deep. Silver ore from the Honolulu mine was treated by chlorination and precipitates shipped to East Helena. The Moulton and Poser mines produced siliceous silver ore and lead-zinc ore, which was milled in the Timber Butte plant. Other shippers were the Flint Creek, Highland, Humboldt, Isele, Little Darling, Minnie Irvine, Minnie Jane, Narrow Gauge, Non-Consolidated, Brittania, Brilliant, Snowdrift, Venus, Muncie, Gagnon, Little St. Lawrence, General Sheridan, Glengary, and Cripple mines. No ore was shipped from the Tuolumne mine, but the company [12] gave the following data on development:

During the past year operations at your properties have been confined entirely to development and repair work. Due to the very low copper market which prevailed during the past year production of ore has not been resumed. * * *

The Main Range mine has been operated continuously during the past year, and 2,084 feet of work was done. * * *

[11] Butte Copper & Zinc Co. Sixth Ann. Rept., for year ending Dec. 31, 1922.
[12] Tuolumne Copper Mining Co. Ann. Rept. for year ending Dec. 31, 1922.

The sinking of the Main Range shaft below the 1,600-foot level was begun late in December, 1921. During the early part of 1922 excellent progress was made in this work, but with the partial resumption of mining operations throughout the West it became exceedingly difficult to secure efficient labor, and due to the acute shortage of skilled miners during the latter part of 1922 sinking was discontinued when the 2,200 level was reached.

On the 2,000-foot level a station has been cut and a crosscut extended to the Spread Delight vein. This vein shows a width of approximately 60 feet in the 2,000 crosscut and is well mineralized for its entire width. Toward the footwall side of the vein an ore shoot was encountered carrying an average of 1 per cent copper and 22 ounces of silver across a width of 8 feet. This ore shoot is entirely distinct from the ore shoot developed on the levels above, from which there has been produced copper, silver, and gold of the value of $1,135,000.

## SWEET GRASS COUNTY.

A test shipment of sulphide lead ore containing silver was made from the Granite Mountain mine, which is being developed by the Belle Mining Co.

# GOLD, SILVER, COPPER, LEAD, AND ZINC IN ARIZONA.

(MINES REPORT.)

By V. C. Heikes.[1]

## PRODUCTION.

The value of the mine production of gold, silver, copper, lead, and zinc in Arizona in 1922 was $62,902,725, or more than double that of 1921. The large mines resumed operations in the second quarter of the year, after being idle a large part of 1921. Dividends were paid to stockholders by the New Cornelia, Miami Copper, Calumet & Arizona, United Verde Extension, United Verde, and United Eastern mining companies, amounting to $7,609,571. The Phelps Dodge Corporation, operating mines at Bisbee and Morenci and also in Mexico and New Mexico, paid $2,000,000, which is not included in the total given above.

The output of all metals produced in Arizona increased considerably in both quantity and value. The average value of the ore increased from $5.42 a ton in 1921 to $5.85 in 1922, but the value in gold and silver decreased from 99 cents a ton to 75 cents.

*Mine production of gold, silver, copper, lead, and zinc in Arizona in 1921 and 1922.*

| Year- | Number of producers. | Ore. | Gold.[a] | Silver.[a] | Copper. | Lead. | Recoverable zinc. | Total value. |
|---|---|---|---|---|---|---|---|---|
| | | *Short tons.* | | *Fine ounces.* | *Pounds.* | *Pounds.* | *Pounds.* | |
| 1921 | 215 | 5,455,030 | $2,930,303 | 2,469,394 | 185,034,194 | 6,541,433 | ..... | $29,563,472 |
| 1922 | 318 | 10,746,045 | 3,524,134 | 4,531,864 | 400,043,128 | 15,070,894 | 210,624 | 62,902,725 |
| Increase, 1922.. | 103 | 5,291,015 | 593,831 | 2,062,470 | 215,008,934 | 8,529,461 | 210,624 | 33,339,253 |

[a] Includes placer production.

## THE TREND OF MINING IN ARIZONA.

The following tables give the production of the State in the last 13 years, together with a separation of the output by kinds of ore. In recent years much siliceous ore was mined for converter lining at the copper smelters. Most of the output was from the Tombstone and Turquoise districts, of Cochise County, and several districts in Yavapai County. A larger output of siliceous ore was maintained throughout the period from mines in the San Francisco district, where treatment of such ore by cyanidation has been continuous since 1903, first at the Gold Road mine, then in 1908 by the Tom Reed Co., and in 1915 at the United Eastern mine, whose output was the largest.

[1] Valuable assistance in the preparation of this report and the compilation of the statistical tables was rendered by B. N. Patchell, of the United States Geological Survey.

The production of copper ores in Arizona began in 1873, at Morenci, and in 1880 Bisbee became an important producer. At this time the ores of the old silver district at Globe became valuable chiefly for copper. In 1887 production of copper began at the United Verde mine, in the Verde district. These four districts were producing the larger part of the total of 200,000,000 pounds in 1904, when the Silver Bell district, in Pima County, began its output of copper. The increase in copper from the several districts continued each year, and in 1911 the Ray Consolidated, in the Mineral Creek district, added its large output, followed in 1917 by the production of the New Cornelia mine, in the Ajo district. Since 1910 Arizona has been the largest producer of copper in the United States. The maximum was reached by the Arizona mines in 1918, when 764,856,000 pounds of copper was produced, but curtailment was marked from 1919 to 1921. Except for the lack of efficient labor, conditions at the copper mines are excellent for the quick renewal of production on a scale equal to any former output.

Mining of lead ore in recent years has been confined largely to Cochise County, particularly the Warren district. No new deposits of lead have been discovered in Arizona that would tend to increase production materially, but higher prices for the product would stimulate the working of lower-grade lead deposits.

The mining of copper-lead ore was never of great importance in Arizona. Most of the ore containing considerable copper and lead has been mined in the Patagonia district, in Santa Cruz County, and in 1920 the old Silver King mine, in the Pioneer district, Pinal County, was a producer of similar ore.

The mining of zinc ore and lead-zinc ore was carried on steadily as fast as workable deposits were found, and some of these were largely depleted within the period shown by the table. In 1916 and 1917 Union Pass and Chloride, in Mohave County, had the largest output, and the mines of these districts may be large producers in the future. At the present time the demand of the oxide plants for zinc-lead ore has been directed to the Warren district, Cochise County.

*Mine production of gold, silver, copper, lead, and zinc in Arizona, 1910–1922.*

| Year. | Ore. | Gold. | Silver. | Copper. | Lead. | Zinc. | Total value. |
|---|---|---|---|---|---|---|---|
| | *Short tons.* | *Fine ounces.* | *Fine ounces.* | *Pounds.* | *Pounds.* | *Pounds.* | |
| 1910 | 3,914,969 | 152,350.58 | 2,566,528 | 297,491,151 | 2,696,998 | 5,484,899 | $42,731,519 |
| 1911 | 4,567,139 | 165,950.58 | 3,276,571 | 306,141,538 | 10,274,552 | 4,562,984 | 44,157,223 |
| 1912 | 6,840,082 | 181,996.91 | 3,490,387 | 365,038,649 | 6,806,443 | 8,758,243 | 67,050,784 |
| 1913 | 7,931,862 | 194,656.69 | 3,948,091 | 407,923,402 | 16,144,772 | 9,428,067 | 70,875,027 |
| 1914 | 8,009,927 | 202,166.62 | 4,377,994 | 393,017,400 | 15,003,068 | 9,792,337 | 59,956,029 |
| 1915 | 9,612,559 | 201,531.46 | 5,649,020 | 459,972,295 | 21,738,969 | 18,220,863 | 90,806,349 |
| 1916 | 17,033,810 | 192,801.41 | 7,212,039 | 721,833,169 | 27,062,087 | 19,677,949 | 190,806,170 |
| 1917 | 15,770,193 | 245,173.83 | 6,983,913 | 712,166,891 | 23,465,445 | 20,894,860 | 209,393,802 |
| 1918 | 19,038,486 | 262,919.43 | 6,686,152 | 764,855,874 | 12,503,689 | 2,269,643 | 202,134,880 |
| 1919 | 13,727,403 | 217,997.72 | 5,266,605 | 538,100,844 | 10,203,078 | 1,717,000 | 111,157,872 |
| 1920 | 14,920,478 | 231,528.65 | 5,355,303 | 558,256,302 | 14,599,765 | 1,457,296 | 114,628,584 |
| 1921 | 5,455,030 | 141,753.41 | 2,469,394 | 185,034,194 | 6,541,433 | ..... | 29,563,472 |
| 1922 | 10,746,045 | 170,479.98 | 4,531,864 | 400,043,128 | 15,070,894 | 210,624 | 62,902,725 |
| | 137,567,983 | 2,561,307.27 | 61,813,861 | 6,109,874,837 | 182,111,193 | 102,474,765 | 1,296,164,436 |

*Content of ores sold or treated in Arizona, 1910–1922*

**Dry and siliceous ore.**

| Year. | Ore. | Gold. | Silver. | Copper. | Lead. | Recoverable zinc. |
|---|---|---|---|---|---|---|
| | *Short tons.* | *Fine ounces.* | *Fine ounces.* | *Pounds.* | *Pounds.* | *Pounds.* |
| 1910 | 255,391 | 95,395.07 | 440,126 | 648,348 | 175,035 | ..... |
| 1911 | 243,900 | 104,011.72 | 414,981 | 730,140 | 111,580 | 8,913 |
| 1912 | 250,142 | 112,067.76 | 373,255 | 87,426 | 215,962 | ..... |
| 1913 | 297,288 | 123,766.86 | 392,413 | 983,400 | 679,415 | ..... |
| 1914 | 428,805 | 145,255.71 | 1,133,976 | 1,210,305 | 679,549 | ..... |
| 1915 | 340,798 | 104,350.00 | 994,184 | 488,011 | 305,724 | 48,580 |
| 1916 | 336,304 | 73,414.67 | 997,372 | 162,897 | 114,489 | ..... |
| 1917 | 317,716 | 131,997.57 | 848,500 | 829,737 | 309,219 | ..... |
| 1918 | 295,548 | 149,999.60 | 917,973 | 732,519 | 16,626 | ..... |
| 1919 | 294,675 | 135,941.83 | 1,031,185 | 731,813 | 45,642 | ..... |
| 1920 | 280,701 | 149,518.03 | 1,051,982 | 505,153 | 46,123 | ..... |
| 1921 | 233,201 | 116,457.77 | 580,349 | 121,903 | 56,171 | ..... |
| 1922 | 246,286 | 108,415.11 | 1,012,558 | 291,677 | 762,602 | ..... |
| | 3,820,755 | 1,550,588.70 | 10,188,854 | 7,523,329 | 3,518,137 | 57,493 |

**Copper ore.**

| | | | | | | |
|---|---|---|---|---|---|---|
| 1910 | 3,644,495 | 52,707.40 | 1,934,363 | 296,739,350 | 5,016 | ..... |
| 1911 | 4,274,209 | 51,377.93 | 2,136,121 | 305,110,593 | 8,037 | ..... |
| 1912 | 6,542,154 | 57,507.81 | 2,378,593 | 364,638,161 | 16,065 | ..... |
| 1913 | 7,553,935 | 64,437.34 | 2,885,115 | 405,963,634 | 9,206 | ..... |
| 1914 | 7,508,020 | 50,842.80 | 2,604,371 | 391,020,335 | 6,024 | ..... |
| 1915 | 9,134,425 | 87,706.63 | 4,010,510 | 458,423,611 | 1,011 | ..... |
| 1916 | 16,491,971 | 105,467.71 | 5,347,893 | 719,702,789 | 27,500 | ..... |
| 1917 | 15,245,297 | 98,530.97 | 5,214,411 | 710,067,644 | 60,287 | ..... |
| 1918 | 18,647,039 | 108,750.43 | 5,347,618 | 763,766,399 | 3,465 | ..... |
| 1919 | 13,347,182 | 78,103.32 | 3,711,052 | 537,201,237 | 179 | ..... |
| 1920 | 14,516,580 | 76,402.41 | 3,716,246 | 557,364,143 | ..... | ..... |
| 1921 | 5,181,177 | 21,732.17 | 1,241,436 | 184,812,780 | ..... | ..... |
| 1922 | 10,431,729 | 57,745.04 | 2,766,277 | 399,264,191 | 2,812 | ..... |
| | 132,518,213 | 911,311.96 | 43,294,006 | 6,094,074,867 | 139,602 | ..... |

**Lead ore.**

| | | | | | | |
|---|---|---|---|---|---|---|
| 1910 | 6,240 | 1,600.09 | 119,034 | 35,749 | 1,584,440 | ..... |
| 1911 | 22,039 | 6,651.95 | 635,363 | 269,197 | 7,618,941 | ..... |
| 1912 | 20,960 | 6,363.49 | 599,110 | 73,896 | 4,555,651 | ..... |
| 1913 | 28,551 | 2,340.62 | 498,457 | 630,815 | 9,609,597 | ..... |
| 1914 | 26,687 | 2,188.48 | 493,226 | 451,504 | 9,653,839 | ..... |
| 1915 | 48,536 | 2,735.36 | 393,444 | 955,665 | 14,892,854 | ..... |
| 1916 | 73,747 | 5,793.20 | 539,108 | 786,960 | 20,087,853 | ..... |
| 1917 | 82,285 | 5,739.02 | 553,544 | 726,779 | 16,289,714 | ..... |
| 1918 | 79,811 | 3,689.47 | 362,182 | 215,746 | 11,419,226 | ..... |
| 1919 | 76,247 | 3,701.41 | 441,739 | 137,546 | 10,088,794 | ..... |
| 1920 | 116,269 | 5,352.21 | 521,441 | 213,346 | 13,641,815 | ..... |
| 1921 | 40,511 | 2,947.62 | 645,563 | 89,263 | 6,435,217 | ..... |
| 1922 | 67,138 | 3,723.28 | 744,559 | 461,980 | 14,119,456 | ..... |
| | 689,021 | 52,826.20 | 6,546,770 | 5,048,446 | 139,997,397 | ..... |

**Copper-lead ore.**

| | | | | | | |
|---|---|---|---|---|---|---|
| 1910 | 1,193 | 101.01 | 38,611 | 67,704 | 430,153 | ..... |
| 1911 | 129 | 13.01 | 5,102 | 10,603 | 101,597 | ..... |
| 1912 | 315 | 84.03 | 18,680 | 26,731 | 114,748 | ..... |
| 1913 | 4,834 | 329.43 | 33,565 | 311,835 | 897,249 | ..... |
| 1914 | 4,892 | 108.75 | 31,991 | 316,684 | 769,586 | ..... |
| 1915 | 426 | 103.38 | 13,923 | 45,502 | 125,230 | ..... |
| 1916 | 3,900 | 36.28 | 30,476 | 328,731 | 931,520 | ..... |
| 1917 | 1,610 | 54.76 | 33,647 | 141,130 | 432,484 | ..... |
| 1918 | 916 | 34.83 | 17,578 | 90,374 | 221,259 | ..... |
| 1919 | 7,261 | 24.09 | 82,593 | 30,248 | 68,463 | ..... |
| 1920 | 5,108 | 35.07 | 65,619 | 173,660 | 842,037 | ..... |
| 1921 | 141 | 10.00 | 1,956 | 10,248 | 50,045 | ..... |
| 1922 | 435 | 16.97 | 8,357 | 25,280 | 101,673 | ..... |
| | 31,160 | 951.61 | 382,098 | 1,578,730 | 5,086,044 | ..... |

*Content of ores sold or treated in Arizona, 1910–1922*—Continued.

Zinc ore and lead-zinc ore.

| Year. | Ore. | Gold. | Silver. | Copper. | Lead. | Recoverable zinc. |
|---|---|---|---|---|---|---|
| | *Short tons.* | *Fine ounces.* | *Fine ounces.* | *Pounds.* | *Pounds.* | *Pounds.* |
| 1910 | 7,650 | 1,289.74 | 34,227 | ..... | 502,354 | 5,484,899 |
| 1911 | 26,862 | 2,752.34 | 84,850 | 21,005 | 2,434,397 | 4,554,071 |
| 1912 | 26,511 | 3,891.47 | 120,361 | 212,435 | 1,904,017 | 8,758,243 |
| 1913 | 44,254 | 2,184.52 | 136,868 | 22,676 | 4,948,467 | 9,370,907 |
| 1914 | 41,523 | 2,312.86 | 114,189 | 18,572 | 3,894,070 | 9,792,337 |
| 1915 | 88,374 | 4,930.97 | 236,650 | 59,506 | 6,414,150 | 18,172,283 |
| 1916 | 108,608 | 5,870.21 | 251,511 | 310,766 | 5,815,725 | 18,252,592 |
| 1917 | 111,910 | 6,431.21 | 306,212 | 201,250 | 6,343,231 | 20,094,966 |
| 1918 | 15,172 | 240.28 | 40,768 | 50,836 | 843,113 | 2,269,643 |
| 1919 | 2,038 | ..... | ..... | ..... | ..... | 1,717,000 |
| 1920 | 1,820 | ..... | ..... | ..... | 69,790 | 1,457,296 |
| 1921 | ..... | ..... | ..... | ..... | ..... | ..... |
| 1922 | 457 | ..... | ..... | ..... | 84,351 | 210,624 |
| | 475,179 | 29,903.60 | 1,325,636 | 897,046 | 33,253,665 | 100,134,861 |

## ORE.

Copper ore was mined in greatest quantity in Arizona in 1922, followed by gold ore and dry and siliceous silver ore. The total values of the ores not shown in the accompanying table are as follows: Dry gold ore, $2,184,041; dry gold and silver ore, $65,757; dry silver ore, $1,085,218; copper ore, $57,860,794; lead ore, $1,660,463; copper-lead ore, $17,713; and lead-zinc ore, $16,645. The placers produced gold and silver valued at $12,094, which makes the State total $62,902,725.

*Ore and metals proauced in Arizona in 1922.*

| Source of production. | Ore. | | Gold. | | Silver. | |
|---|---|---|---|---|---|---|
| | Short tons. | Per cent. | Fine ounces. | Per cent. | Fine ounces. | Per cent. |
| Dry gold ore | 173,070 | 1.61 | 102,814.10 | 60.31 | 58,037 | 1.28 |
| Dry gold and silver ore | 2,031 | .02 | 1,351.19 | .79 | 33,968 | .75 |
| Dry silver ore | 71,185 | .66 | 4,249.82 | 2.49 | 920,553 | 20.31 |
| Copper ore | 10,431,729 | 97.08 | 57,745.04 | 33.87 | 2,766,277 | 61.04 |
| Lead ore | 67,138 | .63 | 3,723.28 | 2.19 | 744,559 | 16.43 |
| Copper-lead ore | 435 | ..... | 16.97 | .01 | 8,357 | .19 |
| Lead-zinc ore | 457 | ..... | ..... | ..... | ..... | ..... |
| Total deep mines | 10,746,045 | 100.00 | 169,900.40 | 99.66 | 4,531,751 | 100.00 |
| Total placers | ..... | ..... | 579.58 | .34 | 113 | ..... |
| Total, deep mines and placers, 1922 | 10,746,045 | ..... | 170,479.98 | 100.00 | 4,531,864 | 100.00 |
| Total, deep mines and placers, 1921 | 5,455,030 | ..... | 141,753.41 | ..... | 2,469,394 | ..... |
| Increase, 1922 | 5,291,015 | ..... | 28,726.57 | ..... | 2,062,470 | ..... |

| Source of production. | Copper. | | Lead. | | Zinc. | |
|---|---|---|---|---|---|---|
| | Pounds. | Per cent. | Pounds. | Per cent. | Pounds. | Per cent. |
| Dry gold ore | 3,140 | ..... | 4,066 | 0.03 | ..... | ..... |
| Dry gold and silver ore | 27,578 | 0.01 | 2,445 | .01 | ..... | ..... |
| Dry silver ore | 260,959 | .07 | 756,091 | 5.02 | ..... | ..... |
| Copper ore | 399,264,191 | 99.80 | 2,812 | .02 | ..... | ..... |
| Lead ore | 461,980 | .11 | 14,119,456 | 93.69 | ..... | ..... |
| Copper-lead ore | 25,280 | .01 | 101,673 | .67 | ..... | ..... |
| Lead-zinc ore | ..... | ..... | 84,351 | .56 | 210,624 | 100.00 |
| Total deep mines | 400,043,128 | 100.00 | 15,070,894 | 100.00 | 210,624 | 100.00 |
| Total deep mines, 1921 | 185,034,194 | ..... | 6,541,433 | ..... | ..... | ..... |
| Increase, 1922 | 215,008,934 | ..... | 8,529,461 | ..... | 210,624 | ..... |

## GOLD ORE.

Gold ore, which represented less than 2 per cent of the total output of ore, was mined by 72 producers in 1922, against 26 in 1921. This ore averaged $12.28 in gold and 0.34 ounce of silver, or $12.62 in all, to the ton. Yavapai County had the largest number of gold producers (23), but the largest quantity of gold ore was reported by 19 producers in Mohave County, followed by Maricopa County with 6 producers.

*Content of dry gold ore sold or treated in Arizona in 1922.*

| County. | Ore. | Gold. | Silver. | Copper. | Lead. |
|---|---|---|---|---|---|
| | *Short tons.* | *Fine ounces.* | *Fine ounces.* | *Pounds.* | *Pounds.* |
| Cochise | 96 | 95.75 | 162 | 38 | 1,190 |
| Gila | 57 | 29.54 | 11 | ..... | ..... |
| Greenlee | 6 | 17.00 | 32 | ..... | ..... |
| Maricopa | 1,706 | 347.43 | 100 | ..... | ..... |
| Mohave | 169,431 | 101,183.49 | 56,044 | 499 | ..... |
| Pima | 302 | 95.03 | 311 | 83 | 2,876 |
| Pinal | 50 | 40.38 | 12 | ..... | ..... |
| Santa Cruz | 8 | 6.00 | 1 | ..... | ..... |
| Yavapai | 814 | 539.79 | 1,206 | 2,503 | ..... |
| Yuma | 600 | 459.69 | 158 | 17 | ..... |
| | 173,070 | 102,814.10 | 58,037 | 3,140 | 4,066 |

## GOLD AND SILVER ORE.

Only four counties recorded a production of gold-silver ore, which averaged $13.75 in gold and 16.72 ounces of silver to the ton, with a little lead and copper, and had a value of $32.38 a ton.

*Content of dry gold and silver ores sold or treated in Arizona in 1922.*

| County. | Ore. | Gold. | Silver. | Copper. | Lead. |
|---|---|---|---|---|---|
| | *Short tons.* | *Fine ounces.* | *Fine ounces.* | *Pounds.* | *Pounds.* |
| Cochise | 10 | 5.72 | 177 | ..... | ..... |
| Maricopa | 4 | 1.90 | 25 | ..... | ..... |
| Pima | 32 | 11.00 | 347 | 90 | 2,445 |
| Yavapai | 1,985 | 1,332.57 | 33,419 | 27,488 | ..... |
| | 2,031 | 1,351.19 | 33,968 | 27,578 | 2,445 |

## SILVER ORE.

Of the silver ore, reported by 86 producers, the largest quantity came from mines in Cochise County, reported by 20 producers, principally in the Turquoise and Tombstone districts. This ore averaged $1.23 in gold and 12.93 ounces of silver to the ton and a little copper and lead and was valued at $15.25 a ton.

*Content of dry silver ore sold or treated in Arizona in 1922.*

| County. | Ore. | Gold. | Silver. | Copper. | Lead. |
|---|---|---|---|---|---|
| | *Short tons.* | *Fine ounces.* | *Fine ounces.* | *Pounds.* | *Pounds.* |
| Cochise | 66,524 | 4,008.27 | 786,551 | 207,377 | 734,833 |
| Gila | 1,564 | 9.20 | 34,904 | 39,921 | 16,534 |
| Greenlee | 20 | 2.00 | 344 | ..... | ..... |
| Mohave | 211 | 64.62 | 12,985 | 261 | 2,169 |
| Pima | 42 | 1.00 | 1,276 | 948 | 1,127 |
| Pinal | 1,026 | 91.02 | 27,701 | 798 | 1,428 |
| Santa Cruz | 1,159 | 45.86 | 17,598 | 3,939 | ..... |
| Yavapai | 632 | 27.24 | 38,502 | 7,619 | ..... |
| Yuma | 7 | .61 | 692 | 96 | ..... |
| | 71,185 | 4,249.82 | 920,553 | 260,959 | 756,091 |

## COPPER ORE.

Of the copper ore mined in Arizona 8,445,443 tons came from low-grade disseminated deposits worked by four producers near Globe, Ray, and Ajo, where most of the ore was treated. The richer siliceous ore, or that valuable as converter lining, was shipped to smelters. Similar disseminated copper ore, amounting to 256,763 tons, was mined and milled from the low-grade copper deposits in the Clifton and Morenci camps, Greenlee County. The crude copper ore mined and smelted directly (without previous concentration) amounted to 1,457,773 tons. The total output of copper ore mined and treated in 1922 averaged 11 cents in gold and 0.27 ounce of silver to the ton and 1.91 per cent of copper and was valued in all at $5.55 a ton, compared with $4.93 in 1921.

*Content of copper ore sold or treated in Arizona in 1922.*

| County. | Ore. | Gold. | Silver. | Copper. | Lead. |
|---|---|---|---|---|---|
| | *Short tons.* | *Fine ounces.* | *Fine ounces.* | *Pounds.* | *Pounds.* |
| Cochise | 736,481 | 29,486.50 | 1,324,294 | 79,518,083 | ..... |
| Gila | 6,253,593 | 6,432.93 | 498,418 | 169,986,496 | ..... |
| Graham | 14 | ..... | 79 | 3,624 | ..... |
| Greenlee | 256,800 | 903.23 | 34,504 | 14,176,777 | ..... |
| Maricopa | 36 | ..... | 18 | 7,189 | ..... |
| Mohave | 1,710 | 48.60 | 11,114 | 73,161 | ..... |
| Pima | 1,344,219 | 32.86 | 4,030 | 27,105,656 | ..... |
| Pinal | 1,197,183 | 390.15 | 32,733 | 28,034,372 | ..... |
| Santa Cruz | 565 | 168.80 | 5,891 | 104,862 | 2,812 |
| Yavapai | 596,284 | 20,269.82 | 850,433 | 76,565,002 | ..... |
| Yuma | 44,844 | 12.15 | 4,763 | 3,688,969 | ..... |
| | 10,431,729 | 57,745.04 | 2,766,277 | 399,264,191 | 2,812 |

## LEAD, COPPER-LEAD, AND LEAD-ZINC ORE.

Lead ore was mined in eight counties by 48 producers, who reported an output averaging $1.15 in gold and 11.09 ounces of silver to the ton, 10.52 per cent of lead, and a little copper, valued in all at $24.73 a ton. Most of the output of seven producers of lead ore in Cochise County came from mines near Bisbee, in the Warren district. In Mohave County four mines produced 13,838 tons of lead ore, the largest part of which was mined in the Owens district. Four producers in Gila County reported 10,975 tons of lead ore, 15 producers in Santa Cruz County reported 1,729 tons, and two producers in Yavapai County reported 1,514 tons.

Copper-lead ore (435 tons) was reported from mines in Gila, Pima, Pinal, Santa Cruz, and Yavapai counties, and a large quantity of lead-zinc ore was shipped from the Warren district, Cochise County.

*Content of lead ore sold or treated in Arizona in 1922.*

| County. | Ore. | Gold. | Silver. | Copper. | Lead. |
|---|---|---|---|---|---|
| | *Short tons.* | *Fine ounces.* | *Fine ounces.* | *Pounds.* | *Pounds.* |
| Cochise | 38,159 | 2,958.23 | 544,488 | 202,949 | 8,649,983 |
| Gila | 10,975 | 400.00 | 43,314 | 191,655 | 4,310,391 |
| Maricopa | 7 | ..... | 44 | ..... | 5,000 |
| Mohave | 13,838 | 290.02 | 94,838 | 4,279 | 231,814 |
| Pima | 889 | 35.00 | 11,502 | 10,872 | 215,527 |
| Pinal | 27 | 7.00 | 1,912 | 420 | 4,705 |
| Santa Cruz | 1,729 | 32.03 | 23,114 | 50,491 | 624,435 |
| Yavapai | 1,514 | 1.00 | 25,347 | 1,314 | 77,601 |
| | 67,133 | 3,723.28 | 744,559 | 461,980 | 14,119,456 |

*Content of copper-lead ore sold or treated in Arizona in 1922.*

| County. | Ore. | Gold. | Silver. | Copper. | Lead. |
|---|---|---|---|---|---|
| | *Short tons.* | *Fine ounces.* | *Fine ounces.* | *Pounds.* | *Pounds.* |
| Gila | 88 | ..... | 3,063 | 8,555 | 17,686 |
| Pima | 128 | 11.00 | 2,648 | 9,185 | 53,234 |
| Pinal | 27 | 3.00 | 481 | 1,856 | 18,769 |
| Santa Cruz | 32 | 1.97 | 1,799 | 2,108 | 7,386 |
| Yavapai | 160 | 1.00 | 366 | 3,576 | 4,598 |
| | 435 | 16.97 | 8,357 | 25,280 | 101,673 |

## GOLD.

Of the total gold output 60 per cent was recovered from ore and tailings treated in gold and silver mills, and nearly 36 per cent consisted of gold in crude ore shipped to smelters. From ores treated in mills by amalgamation gold valued at $13,251 was recovered, and from ores treated by cyanidation, $2,100,516. Concentrates contained $136,379, against $96,189 in 1921, and ores shipped directly to smelters contained $1,260,989, against $477,493 in 1921. The chief gold-producing districts were the San Francisco district, Mohave County, where siliceous gold ores were produced; the Warren district, Cochise County; and the Verde district, Yavapai County, where copper ores were produced.

Of the mines producing gold the United Eastern was first, with 74,221.30 ounces, and the Calumet & Arizona was second. The Tom Reed, at Oatman; the United Verde, at Jerome; and the Copper Queen, at Bisbee, made the next largest outputs of gold.

## SILVER.

The largest increase in silver was recorded in Cochise County. Bullion from gold and silver ores contained 151,837 ounces of silver recovered by cyanidation and 291 ounces recovered by amalgamation. Concentrates contained nearly 11 per cent of the total output of silver, and crude ore shipped to smelters more than 85 per cent.

Of the total silver 65 per cent came from the ore of the Copper Queen, Calumet & Arizona, United Verde, and Tombstone mines.

## COPPER.

The output of copper in 1922 was less than the average of the last ten years and only about half the record output of 1918. Most of the copper mines resumed operations in April or May but did not reach the usual rate of production until late in the year. Of the copper nearly 51 per cent was contained in concentrates, nearly 43 per cent in shipping ore, and nearly 7 per cent in ore leached. Of the output from crude ore smelted in 1922 Cochise County produced nearly 47 per cent and Yavapai County more than 44 per cent. The copper from ore milled came principally from Gila County. The low-grade disseminated ores in Pima, Pinal, and Gila counties yielded 191,854,773 pounds of copper, against 99,056,957 pounds in 1921. Similar low-grade copper deposits were worked in Greenlee County, so that the total production from the disseminated deposits in Arizona was 206,030,072 pounds. In 1921 these ores altogether produced 110,477,423 pounds of copper.

Ten properties, each yielding more than 10,000,000 pounds, produced more than 94 per cent of the total quantity of copper. The Inspiration was first, followed by the Miami, Copper Queen, United Verde, United Verde Extension, Calumet & Arizona, Ray Consolidated, New Cornelia, Old Dominion, and Phelps Dodge mine at Morenci.

## LEAD AND ZINC.

The largest yield of lead was in silver-lead ore produced at the Copper Queen mine, at Bisbee, which was followed by mines in Gila and Cochise counties.

All the zinc output came from the Copper Queen mine in 1922. About 450 tons of lead-zinc ore was shipped to an oxide plant.

## MINING INDUSTRY.

The general suspension of mining activities in Arizona during 1921 resulted in the exodus of a large number of laborers formerly employed in the mining industry. Many laborers left the copper camps for the oil fields of the Middle West and Montana, for the harvest fields, and for industrial centers. After the resumption of operations it was difficult to procure the necessary supply of labor, more particularly the skilled miners and mechanics. The increase in wages to $4.40 a shift for common labor and $4.95 for miners possibly helped to retain adequate forces. All the large copper companies, after having ceased production for nearly a year, resumed operations in February and March, 1922, though on a scale much below their capacity. A gradual increase was made as fast as labor could be obtained to work in the mines and mills, and though few new mines reached the maximum, the production at the end of 1922 was about 60 per cent of that in normal times.

## METALLURGIC INDUSTRY.

There were 46 active milling plants in 1922. In 17 of these plants concentration devices were used, and 11 of them adopted the flotation process. Thirteen mills were equipped for the amalgamation process, 11 for cyanidation, 3 for amalgamation and concentration, and 1 for amalgamation and cyanidation. The leaching of copper ore was continued at Ajo, Pima County. The plant was recently described in a series of articles.[2] Experimental work resulted in the manufacture of seamless copper tubes and automobile radiators at Ajo. At Bisbee the Copper Queen branch of the Phelps Dodge Corporation made preparations for heap leaching on a commercial scale.[3] The United Verde at Jerome is also considering the use of heap leaching. The work of the Western Metallurgical Co. at Humboldt on volatilization and subsequent precipitation of the fume by the Cottrell process was continued, and the method will probably soon be proved in a large plant.[4]

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[2] Allen, A. W., The Ajo enterprise of the New Cornelia Copper Co.: Eng. and Min. Jour.-Press, June 3, 10, 17, and July 29, 1922.

[3] Irving, Joseph, Eng. and Min. Jour.-Press, Apr. 29 and May 6, 1922.

[4] Pyrometallurgy: Eng. and Min, Jour.-Press, vol. 115, p. 120, Jan. 20, 1923.

*Gold and silver produced at mills in Arizona in 1922.*

| County. | Ore (short tons). | Bullion (fine ounces) recovered from ore by— | | | | Total value. |
|---|---|---|---|---|---|---|
| | | Amalgamation. | | Cyanidation. | | |
| | | Gold. | Silver. | Gold. | Silver. | |
| Cochise | 18,482 | 19.75 | 8 | 251.89 | 94,005 | $99,628 |
| Gila | 68 | 27.86 | 9 | .13 | 727 | 1,315 |
| Maricopa | [a] 910 | 214.43 | 50 | [b] 88.90 | [b] 55 | 6,375 |
| Mohave | 169,325 | 163.07 | 72 | 100,734.13 | 54,487 | 2,140,289 |
| Pima | [c] 302 | 63.06 | 37 | 31.97 | 158 | 2,160 |
| Pinal | 50 | 40.38 | 12 | ..... | ..... | 847 |
| Santa Cruz | 258 | 6.00 | 1 | 39.89 | 1,596 | 2,546 |
| Yavapai | [d] 264 | 96.03 | 98 | [e] 21.97 | [e] 657 | 3,194 |
| Yuma | 595 | 10.41 | 4 | 443.60 | 152 | 9,541 |
| | 190,254 | 640.99 | 291 | 101,612.48 | 151,837 | 2,265,895 |

[a] Also yielded 10 tons of concentrates.
[b] Includes bullion from 800 tons of old tailings.
[c] Also yielded 4 tons of concentrates.
[d] Also yielded 10 tons of concentrates.
[e] Includes bullion from 200 tons of old tailings.

Concentration reduced 7,633,387 tons of ore to 470,809 tons of concentrates.

*Mine production of gold, silver, copper, and lead from Arizona concentrates in 1922.*

**By counties.**

| County. | Ore to concentrating mills. | Concentrates produced. | Gold. | Silver. | Copper. | Lead. | Total value of concentrates. |
|---|---|---|---|---|---|---|---|
| | *Short tons.* | *Short tons.* | *Fine ounces.* | *Fine ounces.* | *Pounds.* | *Pounds.* | |
| Cochise | 75 | 8 | 25.00 | 367 | 325 | 179 | $938 |
| Gila | 6,126,433 | 304,331 | 4,831.38 | 282,920 | 157,559,085 | ..... | 21,653,269 |
| Greenlee | 254,183 | 68,095 | 890.29 | 29,317 | 13,529,568 | ..... | 1,874,213 |
| Maricopa | ..... | 10 | 46.00 | 20 | ..... | ..... | 971 |
| Mohave | 15,267 | 787 | 326.66 | 103,809 | 26,814 | 182,404 | 124,214 |
| Pima | 96 | 28 | 1.00 | 593 | 383 | 24,224 | 1,998 |
| Pinal | 1,189,140 | 89,661 | 383.02 | 29,590 | 27,556,702 | 13 | 3,757,664 |
| Santa Cruz | 88 | 22 | ..... | 1,059 | 493 | 5,800 | 1,444 |
| Yavapai | 9,360 | 1,575 | 90.05 | 26,881 | 328,087 | 80,599 | 77,467 |
| Yuma | 38,745 | 6,292 | 3.93 | 3,783 | 3,104,182 | ..... | 422,928 |
| | 7,633,387 | 470,809 | 6,597.33 | 478,339 | 202,105,639 | 293,219 | 27,915,106 |

**By kinds of concentrates.**

| | | | | | | | |
|---|---|---|---|---|---|---|---|
| Dry and siliceous | ..... | 26 | 69.92 | 659 | 316 | 192 | $2,157 |
| Copper | ..... | 470,045 | 6,236.61 | 358,313 | 202,095,491 | ..... | 27,770,126 |
| Lead | ..... | 729 | 289.80 | 119,001 | 6,256 | 288,429 | 141,700 |
| Copper-lead | ..... | 9 | 1.00 | 366 | 3,576 | 4,598 | 1,123 |

**Average content.**

| Kind of concentrates. | Concentrates. | Gold. | Silver. | Copper. | Lead. | Total value. |
|---|---|---|---|---|---|---|
| | *Short tons.* | *Fine ounces per ton.* | *Fine ounces per ton.* | *Per cent.* | *Per cent.* | |
| Dry and siliceous | 26 | 2.69 | 25.35 | 0.61 | 0.37 | $82.96 |
| Copper | 470,045 | .01 | .76 | 21.50 | ..... | 59.08 |
| Lead | 729 | .40 | 163.24 | .43 | 19.78 | 194.38 |
| Copper-lead | 9 | .11 | 40.67 | 19.87 | 25.54 | 124.78 |
| | 470,809 | .01 | 1.02 | 21.46 | .03 | 59.29 |

Of the material smelted the copper ores constituted the largest part. The Warren or Bisbee district, in Cochise County, produced more than 50 per cent. The lead ores formed the next largest quantity, followed by dry and siliceous ore.

*Mine production of gold, silver, copper, lead, and zinc from Arizona crude ore shipped to smelters in 1922.*

**By counties.**

| County. | Crude ore to smelter. | Gold. | Silver. | Copper. | Lead. | Recoverable zinc. | Total value. |
|---|---|---|---|---|---|---|---|
| | *Short tons.* | *Fine ounces.* | *Fine ounces.* | *Pounds.* | *Pounds.* | *Pounds.* | |
| Cochise | 818,062 | 36,211.59 | 2,548,886 | 79,678,779 | 9,470,178 | 210,624 | $14,586,947 |
| Gila | 133,899 | 2,012.30 | 296,054 | 12,599,656 | 4,344,611 | ..... | 2,277,559 |
| Graham | 14 | ..... | 79 | 3,624 | ..... | ..... | 568 |
| Greenlee | 2,643 | 31.94 | 5,563 | 647,209 | ..... | ..... | 93,596 |
| Maricopa | 43 | ..... | 62 | 7,189 | 5,000 | ..... | 1,308 |
| Mohave | 598 | 362.87 | 16,613 | 51,386 | 51,579 | ..... | 33,888 |
| Pima | 5,457 | 89.86 | 19,326 | 577,109 | 250,985 | ..... | 112,897 |
| Pinal | 9,123 | 108.15 | 33,237 | 480,744 | 24,889 | ..... | 101,742 |
| Santa Cruz | 2,716 | 205.77 | 40,363 | 159,342 | 628,833 | ..... | 100,714 |
| Yavapai | 580,969 | 21,963.37 | 921,637 | 75,940,318 | 1,600 | ..... | 11,627,691 |
| Yuma | 6,111 | 14.51 | 1,674 | 584,900 | ..... | ..... | 80,936 |
| | 1,559,635 | 61,000.36 | 3,883,494 | 170,730,256 | 14,777,675 | 210,624 | 29,017,846 |

**By kinds of ore.**

| | | | | | | | |
|---|---|---|---|---|---|---|---|
| Dry and siliceous | 49,463 | 6,042.48 | 841,865 | 289,713 | 759,534 | ..... | $1,047,659 |
| Copper | 1,457,773 | 51,508.43 | 2,407,964 | 169,963,032 | 2,812 | ..... | 26,417,903 |
| Lead | 51,667 | 3,433.48 | 625,674 | 455,807 | 13,833,903 | ..... | 1,519,049 |
| Copper-lead | 275 | 15.97 | 7,991 | 21,704 | 97,075 | ..... | 16,590 |
| Lead-zinc | 457 | ..... | ..... | ..... | 84,351 | 210,624 | 16,645 |

**Average content.**

| Kind of ore. | Crude ore to smelters. | Gold. | Silver. | Copper. | Lead. | Recoverable zinc. | Total value. |
|---|---|---|---|---|---|---|---|
| | *Short tons.* | *Fine ounces per ton.* | *Fine ounces per ton.* | *Per cent.* | *Per cent.* | *Per cent.* | |
| Dry and siliceous | 49,463 | 0.12 | 17.02 | 0.29 | 0.77 | ..... | $21.18 |
| Copper: | | | | | | | |
| Oxidized | 220,580 | .02 | 2.93 | 6.16 | ..... | ..... | 20.06 |
| Sulphide | 1,237,193 | .04 | 1.42 | 5.77 | ..... | ..... | 17.78 |
| Lead: | | | | | | | |
| Oxidized | 38,524 | .07 | 14.12 | .28 | 11.21 | ..... | 28.73 |
| Sulphide | 13,143 | .05 | 6.20 | .92 | 19.77 | ..... | 31.38 |
| Copper-lead: | | | | | | | |
| Oxidized | 106 | .01 | 20.44 | 2.94 | 19.78 | ..... | 50.36 |
| Sulphide | 169 | .09 | 34.46 | 4.57 | 16.31 | ..... | 66.58 |
| Lead-zinc: | | | | | | | |
| Oxidized | 457 | ..... | ..... | ..... | 9.23 | 23.04 | 36.42 |
| | 1,559,635 | .04 | 2.49 | 5.47 | .47 | ..... | 18.61 |

# REVIEW BY COUNTIES.

## GENERAL FEATURES.

*Mine production of gold, silver, copper, lead, and zinc in Arizona in 1922.*

| County. | Gold. | | | | | Silver. | |
|---|---|---|---|---|---|---|---|
| | Placers. | | Deep mines. | | Total value. | Fine ounces. | Value. |
| | Fine ounces. | Value. | Fine ounces. | Value. | | | |
| Cochise | 4.11 | $85 | 36,554.48 | $755,648 | $755,733 | 2,655,673 | $2,655,673 |
| Gila | 11.61 | 240 | 6,871.65 | 142,050 | 142,290 | 579,714 | 579,714 |
| Graham | | | | | | 79 | 79 |
| Greenlee | 30.14 | 623 | 922.22 | 19,064 | 19,687 | 34,886 | 34,886 |
| Maricopa | 37.15 | 768 | 349.32 | 7,221 | 7,989 | 191 | 191 |
| Mohave | 35.99 | 744 | 101,580.73 | 2,099,984 | 2,100,728 | 174,985 | 174,985 |
| Pima | 139.08 | 2,875 | 185.90 | 3,843 | 6,718 | 20,145 | 20,145 |
| Pinal | 11.13 | 230 | 531.54 | 10,988 | 11,218 | 62,841 | 62,841 |
| Santa Cruz | | | 254.65 | 5,264 | 5,264 | 48,403 | 48,403 |
| Yavapai | 279.46 | 5,777 | 22,171.43 | 458,324 | 464,101 | 949,331 | 949,331 |
| Yuma | 30.91 | 639 | 472.48 | 9,767 | 10,406 | 5,616 | 5,616 |
| | 579.58 | 11,981 | 169,900.40 | 3,512,153 | 3,524,134 | 4,531,864 | 4,531,864 |

| County. | Copper. | | Lead. | | Recoverable zinc. | | Total value. |
|---|---|---|---|---|---|---|---|
| | Pounds. | Value. | Pounds. | Value. | Pounds. | Value. | |
| Cochise | 79,928,447 | $10,790,340 | 9,470,357 | $520,870 | 210,624 | $12,006 | $14,734,622 |
| Gila | 170,226,627 | 22,980,595 | 4,344,611 | 238,953 | | | 23,941,552 |
| Graham | 3,624 | 489 | | | | | 568 |
| Greenlee | 14,176,777 | 1,913,865 | | | | | 1,968,438 |
| Maricopa | 7,189 | 970 | 5,000 | 275 | | | 9,425 |
| Mohave | 78,200 | 10,557 | 233,983 | 12,869 | | | 2,299,139 |
| Pima | 27,126,834 | 3,662,123 | 275,209 | 15,136 | | | 3,704,122 |
| Pinal | 28,037,446 | 3,785,055 | 24,902 | 1,370 | | | 3,860,484 |
| Santa Cruz | 151,400 | 21,789 | 634,633 | 34,905 | | | 110,361 |
| Yavapai | 76,607,502 | 10,342,013 | 82,199 | 4,521 | | | 11,759,966 |
| Yuma | 3,689,082 | 498,026 | | | | | 514,048 |
| | 400,043,128 | 54,005,822 | 15,070,894 | 828,899 | 210,624 | 12,006 | 62,902,725 |

*Ore sold or treated, number of deep mines producing, and average value of ore per ton in Arizona in 1921 and 1922.*

| County. | Ore sold or treated, 1922 (short tons). | | Number of deep mines producing. | | Average total value per ton. [a] | | Average value per ton in gold and silver. [a] | |
|---|---|---|---|---|---|---|---|---|
| | Total. | Increase or decrease. | 1921 | 1922 | 1921 | 1922 | 1921 | 1922 |
| Cochise | 841,727 | +397,605 | 29 | 36 | $15.59 | $17.50 | $4.16 | $4.05 |
| Gila | 6,266,277 | +3,393,806 | 32 | 25 | 3.54 | 3.82 | .09 | .12 |
| Graham | 14 | +6 | 1 | 1 | 24.38 | 40.57 | 21.12 | 5.64 |
| Greenlee | 256,826 | −133,155 | 6 | 4 | 3.96 | 7.66 | .18 | .21 |
| Maricopa | 1,753 | +990 | 6 | 10 | 14.97 | 4.94 | 13.10 | 4.23 |
| Mohave | 185,190 | −6,677 | 20 | 38 | 13.34 | 12.41 | 13.25 | 12.28 |
| Pima | 1,345,612 | +416,157 | 13 | 31 | 2.83 | 2.75 | ..... | .02 |
| Pinal | 1,198,313 | +767,370 | 15 | 31 | 4.02 | 3.22 | .30 | .06 |
| Santa Cruz | 3,493 | +2,450 | 16 | 29 | 33.52 | 31.59 | 15.88 | 15.36 |
| Yavapai | 601,389 | +409,425 | 33 | 69 | 20.45 | 19.54 | 2.55 | 2.34 |
| Yuma | 45,451 | +43,038 | 7 | 11 | 11.38 | 11.30 | 1.50 | .34 |
| | 10,746,045 | +5,291,015 | 178 | 285 | 5.42 | 5.85 | .99 | .75 |

[a] Placer product excluded.

## COCHISE COUNTY.

*Mine production of gold, silver, copper, lead, and zinc in Cochise County, Ariz., in 1921 and 1922.*

| Year. | Number of producers. | Ore. | Gold.[a] | Silver.[a] | Copper. | Lead. | Recoverable zinc. | Total value. |
|---|---|---|---|---|---|---|---|---|
| | | *Short tons.* | | *Fine ounces.* | *Pounds.* | *Pounds.* | *Pounds.* | |
| 1921 | 31 | 444,122 | $381,841 | 1,467,145 | 37,420,150 | 5,497,032 | ..... | $6,923,551 |
| 1922 | 37 | 841,727 | 755,733 | 2,655,673 | 79,928,447 | 9,470,357 | 210,624 | 14,734,622 |
| Increase, 1922... | 6 | 397,605 | 373,892 | 1,188,528 | 42,508,297 | 3,973,325 | 210,624 | 7,811,071 |

[a] Includes placer production.

All the metals produced in Cochise County increased in quantity and value in 1922. The value of the output of silver increased from $1,467,145 to $2,655,673, gold from $381,841 to $755,733, copper from $4,827,199 to $10,790,340, and lead from $247,366 to $520,870. The production of zinc in 1922 was 210,624 pounds, valued at $12,006. Ore of smelting grade (818,062 tons) predominated and averaged $17.83 a ton. The total content of each metal is given in the table on page 498. Of the ore smelted 736,431 tons was classified as copper ore, of which 149,270 tons was estimated to be oxidized ore and 587,161 tons sulphide ore. All the lead ore smelted, 38,159 tons, was shipped to plants outside the State and contained 2,958.23 ounces of gold, 544,488 ounces of silver, 202,949 pounds of copper, and 8,649,983 pounds of lead. All but 686 tons of this ore was oxidized. Milling ore produced 5 tons of siliceous concentrate and 3 tons of copper concentrate, which were also shipped. A small placer output was reported by one operator.

*California district.*—Lessees working the Humboldt property produced a car of high-grade silver ore containing a little copper. The mine is opened by an inclined shaft 185 feet deep, and the owner reports a reserve of 2,000 tons of tailings assaying 0.2 ounce of gold and 10 ounces of silver to the ton and 0.5 per cent of copper.

*Cochise district (Johnson, Dragoon).*—Development work, in the course of which a small quantity of copper ore was shipped, was done at the Texas-Arizona property. A small lot of silver-gold ore was also shipped from the Herrera claim.

*Dos Cabezos district.*—Five producers in the Dos Cabezos district reported the mining of 97 tons of ore, which contained $1,418 in gold, 483 ounces of silver, 34 pounds of copper, and 4,182 pounds of lead, valued in all at $2,135, or $22.01 a ton. As a result of attachment proceedings on the Gold Prince property, all valuable material was sold, including some gold concentrate left from former operations. A small quantity of gold bullion was recovered from ore milled from the Jack Dempsey and Gold Belle claims.

The Central Copper Co. of Arizona, lessee of the Mascot property, reported development work amounting to 3,722 feet, which was carried on throughout the year. The 50-ton experimental mill was not operated, and no crude ore was shipped.

*Huachuca district.*—The Wakefield silver-gold group, 7 miles east of Sunnyside post office, on the west side of the Huachuca Moun-

tains, was developed in the first three months of 1922. The property is equipped with a 5-ton concentration mill, and a small quantity of gold ore and concentrate was shipped to the smelter.

*Swisshelm district (Webb).*—No new discoveries were made in the Swisshelm district in 1922. Two cars of gold-silver ore containing lead were shipped from the Four Horse mine. This ore occurs in a contact-metamorphic deposit and is opened by three tunnels, the longest of which is 500 feet in length. About 400 feet of tunnel work was done in 1922.

*Tombstone district.*—Silver at $1 an ounce was the incentive for the larger output of ore in the Tombstone district, part of which was sorted from the old mine dumps by lessees and shipped to smelters and part was milled. Fifteen producers reported the output of 16,730 tons of milling ore and 27,617 tons of ore of smelting grade. The output contained $48,005 in gold, 613,700 ounces of silver, 196,740 pounds of copper, and 744,529 pounds of lead, valued in all at $729,214, or $16.44 a ton. Most of the ore came from the property of the Bunker Hills Mines Co., which, as in the last few years, was worked wholly by lessees. Several classes of ore were shipped during the year; lead and basic ores were shipped to El Paso, Tex., and siliceous, limy, and neutral ores to Douglas. The Oregon, Lucky Cuss, Silver Thread, and Contention mines were the largest producers of the Bunker Hill group. The waste dump of the State of Maine mine was worked over, and considerable ore was treated by concentration and cyanidation by the Old Pueblo Leasing Co. On the Mellgren group, adjoining the State of Maine mine, considerable development work was done, and the silver ore mined and treated in the 100-ton cyanidation plant yielded principally silver with a little gold. Other producers were the Old Guard, Junetta, Fearless, Free Coinage, Bob Ingersoll, Argenta, Rocky Bar, and Side Wheel claims.

*Turquoise district (Courtland, Pearce, Gleeson).*—Six producers of ore in the Turquoise district reported 24,571 tons, containing $39,605 in gold, 190,223 ounces of silver, 138,893 pounds of copper, and 266,546 pounds of lead, valued in all at $263,239, or $10.71 a ton. This output includes 5,108 tons of old tailings shipped to smelters and 1,709 tons of crude ore treated by cyanidation. The Commonwealth mine, which was worked throughout the year, was the largest shipper of ore and tailings, containing principally silver, with some gold. A small quantity of silver ore was also shipped from the Commonwealth Extension mine. At the Mary & Mamie property, near Courtland, lessees shipped some ore mined in 1920 and 1921. This property, which has been operated by the Great Western Copper Co., has an estimated reserve of ore amounting to 1,250,000 tons, containing an average of 2 per cent of copper. At Gleeson the Shannon Copper Co. operated the Leonard mine and shipped copper sulphide ore containing silver and a little gold. The Silver Bill property, in the same vicinity, produced copper-lead ore carrying an average of about 9 ounces of silver to the ton, which was shipped to El Paso, Tex.

*Warren district (Bisbee, Lowell, Warren).*—The Copper Queen and Calumet & Arizona properties were the only large producers in the Warren district in 1922; both shipped about equal quantities of ore to their smelters at Douglas. Some of the sulphide-copper ore mined was shipped to Globe, the lead ore to El Paso, Tex., and the zinc ore

to Colorado and Oklahoma. The output of the district amounted to 772,482 tons of ore, largely from the mines of two companies that resumed production in February. At the Copper Queen property mining was restricted principally to the Southwest and Sacramento divisions. Sufficient sulphide ore to supply the metallurgical needs of the smelters was mined from the Gardner and Lowell mines, which were opened from the Sacramento division. Siliceous ores needed by the smelter were obtained from the upper parts of the southeastern extension of the East ore body and also from an exposure of good ore in the bottom of the West ore body shovel pit. Exploration work was continued on the 1,700 and 1,800 foot levels from the Sacramento winze, and a large mass of sulphide ore was opened. Construction was continued at the concentrator until early spring, when the work was discontinued, the concentrator being practically finished. About 315,000 tons of low-grade copper ore was mined by steam shovel at Bisbee for the leaching heap near Don Luis. It is reported that about 100,000 pounds of copper is extracted annually from the mine water of the Czar shaft, one of the earliest workings in the district. The annual report [5] for the Copper Queen branch showed production to be as follows:

*Ore and metals contained in output of Copper Queen mines, 1922.*

| Kind of material. | Total. | Gold. | Silver. | Copper. | Lead. | Zinc. |
|---|---|---|---|---|---|---|
| Underground: | *Short tons.* | *Ounces.* | *Ounces.* | *Pounds.* | *Pounds.* | *Pounds.* |
| Copper ore | 323,185 | 7,846 | 597,019 | 43,615,027 | ..... | ..... |
| Silver-lead ore | 36,339 | 2,741 | 522,719 | 287,031 | 8,440,028 | ..... |
| Lead-zinc ore | 456 | ..... | ..... | ..... | 120,487 | 247,793 |
| Sacramento Hill: | | | | | | |
| High grade | 28,913 | 1,374 | 12,483 | 3,781,358 | ..... | ..... |
| Low grade | 127 | 11 | 62 | 16,241 | ..... | ..... |
| Precipitates (copper) | 347 | ..... | 21 | 262,466 | ..... | ..... |
| Total, 1922 | 389,367 | 11,972 | 1,132,304 | 47,962,123 | 8,560,525 | 247,793 |
| Total, 1921 | 515,632 | 4,650 | 495,179 | 30,610,173 | 4,916,418 | ..... |
| Total, 1920 | 832,172 | 8,846 | 486,698 | 71,443,396 | 243,836 | ..... |
| Total, 1919 | 606,386 | 10,813 | 492,326 | 68,614,002 | 9,372 | ..... |
| Total, 1918 | 771,063 | 16,409 | 558,433 | 90,988,156 | 1,234,497 | ..... |

The Calumet & Arizona mines [6] produced 342,516 dry tons of ore. Of this amount 297,279 tons, containing 4.76 per cent of copper, was shipped to the Calumet & Arizona smelter at Douglas, 30,606 tons of ore was exchanged with the Copper Queen smelter, and 12,886 tons of low-grade copper ore high in sulphur was shipped to the New Cornelia Copper Co. at Ajo. To the Old Dominion smelter at Globe 3,416 tons of low-grade copper sulphide ore was shipped, and 9,219 tons of similar ore went to the International smelter at Miami. Lead-silver ore shipped to the El Paso lead smelter amounted to 574 tons. Both the Briggs and Junction mines were operated during 1922. In the Nellie claim above the 1,400-foot level and nearly to the 1,300-foot level oxide ore was mined and is continuing north and south. Sulphide deposits 35 to 60 feet wide produced ore containing 3 to 8 per cent of copper in the Ormond claim. Similar ore was developed in the central portion of the Oregon claim on its 1,800-foot level. Dividends paid to stockholders amounted to

[5] Phelps Dodge Corporation Ann. Rept. for year ending Dec. 31, 1922.
[6] Calumet & Arizona Mining Co. Ann. Rept. for year ending Dec. 31, 1922.

$1,285,046.50 in 1922, which, with other dividends paid since 1903, gives a total of $48,200,560.

At the Shattuck property development work on a small scale was started in June, but no ore was shipped. Preparations were made to ship lead ore shortly after the first of January, 1923.

## GILA COUNTY.

*Mine production of gold, silver, copper, and lead in Gila County, Ariz., in 1921 and 1922.*

| Year. | Number of producers. | Ore. | Gold.[a] | Silver.[a] | Copper. | Lead. | Total value. |
|---|---|---|---|---|---|---|---|
| | | *Short tons.* | | *Fine ounces.* | *Pounds.* | *Pounds.* | |
| 1921 | 33 | 2,872,471 | $37,913 | 233,650 | 76,612,995 | 173,346 | $10,162,440 |
| 1922 | 28 | 6,266,277 | 142,290 | 579,714 | 170,226,627 | 4,344,611 | 23,941,552 |
| Increase or decrease, 1922 | −5 | +3,393,806 | +104,377 | +346,064 | +93,613,632 | +4,171,265 | +13,779,112 |

[a] Includes placer production.

In Gila County copper ore was treated at Globe and Miami, but lead ores and part of the copper ores were shipped to plants outside of the county. Of the copper ore smelted, 25,800 tons was sulphide and 95,483 tons oxidized. The 133,899 tons of smelting ores shipped had an average value per ton of $17.01, and 304,331 tons of concentrates, all copper, an average value per ton of $71.15.

*Banner district.*—Lead ore containing silver and a little gold was mined from the Seventy-nine property and shipped to El Paso, Tex. The company operating the property claims a reserve of 20,000 tons of ore, containing 18 per cent of lead.

*Globe district (Miami).*—The output of ore reported by 20 producers in the Globe district amounted to 6,255,277 tons, containing $133,264 in gold, 534,855 ounces of silver, 170,035,442 pounds of copper, and 64,834 pounds of lead, valued in all at $23,626,470, or $3.78 a ton. Most of this ore was reduced to 304,331 tons of concentrates. The chief producers were the Inspiration, with 3,737,702 tons, and the Miami, with 2,181,320 tons; somewhat lesser quantities were produced by the Iron Cap, Arizona Commercial, Old Dominion, and Superior & Boston, and smaller lots were shipped from the El Capitan, Tacoma, Red Star, and Husband-Wills & Snell properties. Lead ore was shipped from unpatented claims of the Globe Dominion Copper Co. in the course of assessment work. From Radium, a station on the Arizona Eastern Railroad, lead-silver ore was shipped from the Crow claims.

Ore mined for the year from the Miami property [7] amounted to 2,181,320 tons, all produced by the undercut-caving method of mining. The ore milled amounted to 2,183,020 tons, or an average of 6,064 tons a day for 360 days. The results of these operations, according to the company's annual report, were as follows:

Ore milled, 2,183,020 tons, at 1.883 per cent copper.
Concentrate produced, 81,425 tons, at 43.601 per cent copper.
Copper in concentrate, 71,004,668 pounds.
Copper per ton ore, 32.526 pounds.
Mill extraction, 86.36 per cent.

[7] Miami Copper Co. Ann. Rept. for year ending Dec. 31, 1922.

The cost of milling ore to the point of concentrate on board cars is as follows:

| | |
|---|---|
| Direct crushing expense | $0.30717 |
| Direct concentrating expense | .24786 |
| Tailing and concentrate handling | .03474 |
| Water for concentrating | .04637 |
| Miscellaneous expense | .00803 |

The total milling cost dropped approximately 6 cents per ton as compared with the previous year, the lower cost being due principally to the larger tonnage treated per section. Metallurgical results during the year were the best in the history of the property. The mill handled a considerably greater tonnage per section and made a copper extraction of 86.36 per cent.

From an operating point of view, the most important development during the year in the mill was the installation of new equipment and the introduction of a new flow sheet in one of the mill sections. Six months operation of this new flow sheet demonstrated an increased capacity of 20 per cent with a lower tailing loss.

The new tailings-elevating plant, consisting of a battery of six Wilfley sand pumps, which was installed in December, 1921, operated very successfully and with considerable economy during the year.

The smelter returns of refined copper on the concentrate shipped amounted to 67,454,447 pounds, and the cost of this copper in concentrate on board cars at Miami was as follows:

| | Per ton ore. | Per pound copper. |
|---|---|---|
| Mining | $1.11304 | $0.035993 |
| Milling | .64417 | .020847 |
| General | .29975 | .009704 |
| | 2.05696 | .066544 |

This shows a decrease in all departments, as compared with the previous year, of approximately 18 cents per ton, which, coupled with a higher yield, has resulted in a net decrease of 1.2 cents per pound of copper.

Production of ore was begun at the Old Dominion mine late in February, and the smelter was blown in April 15. Of the 202,954 dry tons of ore mined, 51,791 tons was smelting ore, averaging 7.65 per cent of copper, 148,225 tons concentrating ore, averaging 4.29 per cent, and 2,938 tons siliceous ore, used for converter lining, averaging 4.13 per cent. The total production for 1922, including the metal from custom ore, was 18,573,289 pounds of refined copper, 122,095 ounces of silver, and 3,316.71 ounces of gold. This output, together with the copper on hand, gave a total of 24,003,623 pounds of refined copper, which sold at an average price of 13.35 cents a pound. Three important discoveries of ore were made during 1922, two in the east end of the sixteenth level on the Old Dominion vein and a third on the nineteenth level (1,500 feet in depth) of the Josh Billings vein.

Operations at the Inspiration property[8] were resumed February 15, and production was gradually increased throughout the year. During the last quarter the output averaged 7,400,000 pounds of copper a month. The ore mined in 1922 contained about 1.25 per cent of copper, and it is expected that the grade of ore will be higher when the Live Oak ore body is worked. The purchase of the property of the Porphyry Copper Co. furnished a favorable site for the extraction shaft for this ore body, which, when equipped and ready to operate, will have a capacity of 10,000 tons or more of ore daily. The mining of this ore will materially increase the average grade of the sulphide ore, as about half the total sulphide output will be drawn from this section of the mine, the ore of which contains more than 1.5 per cent of copper. The total ore mined amounted to

[8] Inspiration Consolidated Copper Co. Ann. Rept. for the year ending Dec. 31, 1922.

3,737,703 tons, of which the Inspiration property produced 3,711,765 tons, containing 1.23 per cent of copper. Development was continued at the Warrior group, which produced 9,518 tons of ore, averaging 6.74 per cent of copper. In the Live Oak section 16,420 tons of ore was mined, averaging 2.34 per cent of copper. Nearly all the ore mined, or 3,688,181 tons, was of milling grade, 32,910 tons was of smelting grade, and 10,513 tons was milled by the Miami Copper Co. Experimental work on the leaching of oxidized ore was continued, and 6,099 tons was treated at the plant. Leaching tests were also made on mixed oxidized and sulphide ores with the subsequent flotation of sulphides in the leached material. The ore was mined at the rate of 14.5 tons per man-shift for all labor chargeable to the mining division, as compared with 19.1 tons for the preceding year. The drop in output per man-shift was due to the necessity of building up and training a practically new underground crew. The total production was 69,834,115 pounds of copper from 3,717,148 tons of ore. From the milling of 3,673,725 tons of ore, including some ore leached, 67,692,953 pounds of copper was produced. The ore smelted, amounting to 32,969 tons, yielded 1,922,040 pounds of copper. The recovery of copper in milling ore was 78.67 per cent. The cost of fine copper produced during the period of operation, including depreciation but excluding depletion, Federal taxes, and shut-down expenses, amounted to 12.14 cents a pound.

The Superior & Boston mine[9] produced 13,046 dry tons of ore, averaging 4.19 per cent of copper and 9.55 ounces of silver to the ton, between October 1, 1921, and September 30, 1922. This ore contained a total of 1,092,979 pounds of copper and 124,634 ounces of silver, for which the company received $172,186.52 after smelting and freight charges were deducted. This ore came from the Footwall and Rigby veins. In addition the company shipped 227 tons of silver ore from the Eclipse vein, averaging 116.75 ounces of silver to the ton, for which $20,873, or an average of $91.96 a ton, was received. The amount received for the output was $193,060, or $14.59 a ton, exclusive of two cars of ore shipped by lessees. At the beginning of the fiscal year operations were confined to mining high-grade silver ore, as the copper smelters were closed. The reopening of the International smelter, at Miami, allowed the company to resume the shipment of copper-silver ore.

Operations at the mine and mill of the Iron Cap Co.[10] were resumed February 1, after an idleness of nearly a year. From 69,675 dry tons of ore, averaging 4.65 per cent of copper and 1.26 ounces of silver to the ton, 94.76 per cent of the copper and 91.27 per cent of the silver were recovered by concentration. The operating cost of milling was $1.88 a dry ton, and the concentrates contained 6,135,916 pounds of copper, 79,908 ounces of silver, and a little gold, valued in all at $869,049.53. Drifts are being extended east on the 900, 1,000, 1,200, and 1,400 foot levels, with indications of opening more mineralized ground.

No work was done during 1922 in the Eureka Hill mine, but production at the Copper Hill mine was resumed by the Arizona Commercial Co.[11] in March. The output was 5,284 dry tons of smelting ore,

[9] Superior & Boston Copper Co. Ann. Rept. for the year ending Sept. 30, 1922.
[10] Iron Cap Copper Co. Tenth Ann. Rept., for year ending Dec. 31, 1922.
[11] Arizona Commercial Mining Co. Ann. Rept. for the year ending Dec. 31, 1922.

averaging 11.08 per cent of copper, and 50,358 tons of concentrating ore, averaging 6.15 per cent of copper. Altogether this ore produced 6,220,923 pounds of refined copper, 27,532 ounces of silver, and 1,585.15 ounces of gold. The output given above, together with some copper on hand, gave a total of 8,999,447 pounds, which was sold at an average price of 13.266 cents a pound. The total sales of copper, silver, and gold amounted to $1,256,779.62. The following paragraphs are taken from the company's report:

The Copper Hill shaft was deepened from the 1,600 level to the 1,800 level, and pumps installed on the deeper level. Work done on the Old Dominion vein, on the 1,700, has disclosed ore of very good grade and conclusively proves that the heretofore best ore in the mine, on the 1,600 level, continues down past the 1,700. Since January 1 the vein has been crosscut on the 1,800 level and found to be better in every respect than any of the levels above.

The total water pumped from the mine during the year was 85 million gallons, as compared with 117 million gallons in 1921. Although a large quantity of water was encountered in the work of sinking the Copper Hill shaft during the year, the general water level of the country has been lowered by very heavy pumping operations in the past.

*Richmond Basin district.*—Very little mining was done in 1922 in the Richmond Basin district. The Jumbo mine was operated, and some silver ore was shipped to El Paso, Tex., by lessees.

*Ward district.*—Gold bullion was recovered from ore treated in an amalgamation mill from the property of the Gold-Copper Mines Co. The mine was equipped with a 20-ton Gibson mill in 1922, and a cyanide plant is planned as soon as more water is developed.

## GRAHAM COUNTY.

*Bunker Hill district (Copper Creek).*—The Concordia mine produced copper ore which was shipped to the smelter at Hayden.

## GREENLEE COUNTY.

*Mine production of gold, silver, copper, and lead in Greenlee County, Ariz., in 1921 and 1922.*

| Year. | Number of producers. | Ore. | Gold.[a] | Silver.[a] | Copper. | Lead. | Total value. |
|---|---|---|---|---|---|---|---|
| | | *Short tons.* | | *Fine ounces.* | *Pounds.* | *Pounds.* | |
| 1921 | 10 | 389,981 | $22,706 | 47,959 | 11,422,397 | 6,246 | $1,544,435 |
| 1922 | 6 | 256,826 | 19,687 | 34,886 | 14,176,777 | ..... | 1,968,438 |
| Increase or decrease, 1922 | −4 | −133,155 | −3,019 | −13,073 | +2,754,380 | −6,246 | +424,003 |

[a] Includes placer production.

*Ashpeak district (Duncan).*—Silver ore hauled from the dump of the Ashpeak mine was shipped from Duncan to El Paso, Tex.

*Copper Mountain and Greenlee districts (Morenci, Metcalf, Clifton).*—Other than a small shipment from the Ashpeak district, the entire output given in the table for Greenlee County was that of the Copper Mountain and Greenlee districts. Most of the ore produced was mined from property controlled by the Phelps Dodge

Corporation. The Humboldt and Coronado mines were operated by this corporation in 1922, and the ore and concentrates were shipped to the Copper Queen smelter, at Douglas. Some copper and gold ores were also shipped to the smelter from the Turkey & Margot and Alienza prospects. The Stargo Mines Co. completed a 75-ton cyanide mill at Morenci and began operations December 19. The total output of the two districts was $19,023 in gold, 34,536 ounces of silver, and 14,176,777 pounds of copper, valued in all at $1,967,424. Operations of the Phelps Dodge Corporation included the working of the former Arizona Copper Co.'s properties and resulted in the production of 260,151 dry tons of ore, containing 12,031,224 pounds of copper, or an average of 2.31 per cent. Work was confined to mining and milling the rest of the ore body adjoining the Mathilda shaft of the Coronado mine. On completion of this work the force was transferred to the Humboldt mine, where preparations were made for future large-scale operations. In the concentration mill only one unit, with a capacity of 700 tons a day, was operated on the new flow sheet at No. 6 concentrator up to December 15, when an additional unit with a daily capacity of 700 tons was started. The concentrator treated 254,183 dry tons of ore, averaging 2.18 per cent of copper, from which was recovered 44,382 tons of concentrate, containing 10.24 per cent of copper. The current output of concentrate and all concentrates in stock at the Clifton smelter January 1, 1922, were shipped to the reduction works at Douglas.

### MARICOPA COUNTY.

At gold and silver mills in Maricopa County 910 tons of ore and 800 tons of old tailing were treated, which produced 10 tons of concentrates and gold and silver bullion valued at $6,375. Ore shipped directly to the smelter, amounting to 43 tons, was valued at $30.42 a ton. A little placer bullion was reported by one operator.

*Salt River district.*—Gold bullion was recovered from ore treated in the milling plant of the Max Delta Mining Co. A small quantity of gold concentrate was also shipped to El Paso, Tex.

*San Domingo district.*—From the Silver Bill group, 4½ miles north of Hot Springs Junction, test shipments of ore containing from 7 to 19 per cent of copper were made to the smelter.

*Vulture district.*—Old tailing treated by cyanidation and ore treated by amalgamation from the El Tigre property yielded gold bullion. About 15 tons of ore from the Neglected group, owned by the Gold Hill Mining & Milling Co., was treated in a Herman ball mill, which is equipped for amalgamation and concentration. Operations were discontinued on account of lack of water. The Last Chance mine, formerly known as the Garcia, was operated, and 5 tons of ore from the mine was shipped to the Consolidated Vanadium Co. Other ore was treated in a 12-ton amalgamation-concentration mill and yielded some bullion, which was shipped to San Francisco, and concentrate, which was not sold. The property is opened by an inclined shaft 100 feet deep and 160 feet of drifts.

## MOHAVE COUNTY.

*Mine production of gold, silver, copper, and lead in Mohave County, Ariz., in 1921 and 1922.*

| Year. | Number of producers. | Ore. | Gold. | Silver. | Copper. | Lead. | Total value. |
|---|---|---|---|---|---|---|---|
| | | *Short tons.* | | *Fine ounces.* | *Pounds.* | *Pounds.* | |
| 1921 | 20 | 191,867 | $2,333,506 | 208,869 | 29,694 | 314,743 | $2,560,369 |
| 1922 | 39 | 185,190 | [a] 2,100,728 | [a] 174,985 | 78,200 | 233,983 | 2,299,139 |
| Increase or decrease, 1922 | +19 | −6,677 | −232,778 | −33,884 | +48,506 | −80,760 | −261,230 |

[a] Includes placer production.

The ore treated in Mohave County by amalgamation or cyanidation, principally the latter, amounted to 169,325 tons, which yielded $2,085,730 in gold and 54,559 ounces of silver, having a total value of $2,140,289, or an average of $12.64 a ton. The concentrating ores (15,267 tons) yielded 787 tons of concentrates, against 1,244 tons of concentrates from 12,020 tons of ore in 1921. The concentrates in 1922 had a total value of $124,214, or an average of $157.83 a ton. Crude ore shipped to smelters amounted to 598 tons, against 629 tons in 1921, and had a total value of $33,888, or an average of $56.67 a ton.

*Cedar Valley district.*—Six producers in the Cedar Valley district reported the shipment of ore and concentrate, much of which had been mined and milled prior to 1922. The output contained $1,984 in gold, 1,333 ounces of silver, and 54,347 pounds of copper, valued in all at $10,654, or $20.25 a ton. Copper ore was shipped from the Antler property by a lessee, and a shipment of silver ore was made from the Diamond Joe claim. A little concentrate containing 22 per cent of copper and 15 ounces of silver to the ton was shipped from the property of the Yucca Tungsten Mining Co.

*Chemehuevis district.*—A little gold bullion recovered from ore from the Dutch Flat and Elsie V claims and silver precipitates recovered by cyanidation from the Little Wanderer property represented the output of the Chemehuevis district.

*Gold Basin district.*—Though the Cyclopic mine was idle, a little gold bullion, probably from former operations, was marketed.

*Indian Secret district.*—The development of the White Hills mine was continued, and a little silver ore containing gold and copper was shipped to the smelter.

*Maynard district.*—Mining and milling operations at the property of the Dean Mines Co. were continued for a short time. Several lots of rich concentrate containing silver and lead, with a little copper and gold, were shipped to the smelter.

*Owens district.*—The McCracken group, consisting of the Alta, Signal or Peabody, and Alta-McCracken claims, was operated under lease by the Signal Mines Co. The concentrate recovered from the ore in the 150-ton flotation-concentration plant carried about 250 ounces of silver and 30 per cent of lead. This product was hauled 40 miles to Yucca, a station on the Atchison, Topeka & Santa Fe

Railway. The diamond drill is said to have developed enough water on the 600-foot level of the McCracken mine for the operation of the mill.

*San Francisco district (Oatman, Gold Road, Vivian).*—Ten producers in the San Francisco district reported the mining and milling of 169,240 tons of ore. The total value of the bullion recovered from the ores produced was $2,138,546 in gold and silver, or $12.64 a ton. Most of the ore was mined from the United Eastern and Tom Reed properties. All the bullion other than that from the Secret Pass property was recovered by cyanidation. Large outputs were reported by the United American, Telluride, Oatman United, and Gold Ore mining companies. Most of the smaller lots of ore mined in the district, with the exception of some ore mined from the Orphan group in Secret Pass, were treated in the Tom Reed mill. The ore from the Orphan group was treated in a 30-ton amalgamation plant equipped with a Lane mill. The property is said to have in reserve about 5,000 tons of ore averaging $9 a ton in gold.

The United Eastern mine[12] produced 117,687 tons of ore, against 97,413 tons in 1921. The greater part of the ore output in 1922, or 80,366 tons, was mined from the third, fourth, fifth, and sixth levels of the Big Jim claim, and the remainder, 37,321 tons, from the seventh, eighth, and ninth levels of the Tom Reed Extension claim. The metal recovery from Big Jim ore was 51,994.72 ounces of gold and 29,045 ounces of silver, and from Tom Reed Extension ore 22,226.9 ounces of gold and 12,178 ounces of silver. These figures include the content of tailing-pond skimmings. The gold recovered by cyanidation was valued at $1,600,925.02 and the silver at $42,-983.52, or a total value of $1,643,908.54. The average value of the ore treated was $13.97, and the tailing loss was 54 cents, representing a recovery of 96.15 per cent, or $13.43 a ton. Mining costs averaged $3.97 a ton, and direct milling $1.75 a ton, which, with marketing and indirect costs, brought the total cost to $7.24. The net income from operations was $6.15 a ton, or $723,341.59. Dividends paid since 1917 have amounted to $4,770,500, of which $817,800, or 60 cents a share of stock, was paid in 1922. The ore reserves were not increased by the discovery of any new ore bodies in 1922. An estimate of ore reserves January 1, 1923, gives the Tom Reed Extension claim 1,543 tons, averaging $6.80 a ton; the Big Jim claim 111,370 tons, valued at $15.03 a ton; and the Big Jim dump 3,575 tons, valued at $13.23 a ton. Altogether the ore reserves are 116,488 tons, valued at $1,731,754, approximately the same quantity of ore as on January 1, 1922, but $683,000 less in estimated value. The company reviews conditions as follows:

> The tonnage of ore mined in 1922 was the largest in the history of the company and was in excess of new tonnage developed. A considerable amount of exploration work was done during the year by means of diamond drilling, but without the discovery of any new ore bodies. In its course northwesterly through the Red Cloud Extension claim the veins seem to have split up into numerous small stringers with little or no precious-metal content. From the No. 2 shaft workings diamond drilling is being conducted to explore the vein below the ore body originally developed on the Tom Reed Extension claim. This drilling is for the purpose of exploring the vein at a depth of about 2,300 feet below the surface and about 1,000 feet below the lower limits of the Tom Reed Extension claim ore body. This work has been very much delayed by a shortage of drillers, and also by a heavy flow of water coming from the hole at a temperature as high as 114°. * * *

[12] United Eastern Mining Co. Ann. Rept. for year ending Dec. 31, 1922.

The cost of drilling at shaft No. 3 was $3.979 per foot, as compared with $5.335 per foot for 1921, a decrease of $1.356 per foot. Dewatering, station preparation, etc., brought the total cost up to $5.879 per foot, as compared with $7.372 for 1921, a decrease of $1.493 per foot. Many of the holes had to be reamed and cased, and for a great part of the time water was bailed continuously on three shifts per day.

The 350 feet of drilling at shaft No. 2 cost $5.281 per foot; with station preparation, $5.492 per foot. Unusually high carbon consumption and difficult ground account for the high costs.

Work was started at the Gold Road mine, 4 miles from Oatman, though no gold was produced. Repairs were made in the 300-ton mill, and the mine was nearly ready for operation at the end of 1922.

*Wallapai district (Cerbat, Chloride, Kingman, Mineral Park, Stockton Hill).*—Fourteen producers in the Wallapai district reported the output of 3,453 tons of ore, most of which, or 3,060 tons, was milled and produced 422 tons of silver-lead concentrate containing some copper and gold. The shipping ore contained principally lead, silver, and gold, with some copper. The total output of ore mined in the district was valued at $61,234, or $17.73 a ton. The C. O. D. property, the largest producer in the preceding year, has been idle since October, 1921, but several lots of lead concentrate, rich in gold and silver, were marketed in 1922. The largest output of silver ore came from the Memphis group, operated by the Dardanelles Mining Co. Smaller shipments of lead ore were made from the Sunday School, St. Louis, and Tuckahoe properties.

*Weaver district (Mocking Bird, Virginia).*—Gold bullion recovered from ore treated in a 3-stamp amalgamation mill on the Zerolene property represented the total production of the Weaver district in 1922.

## PIMA COUNTY.

*Mine production of gold, silver, copper, and lead in Pima County, Ariz., in 1921 and 1922.*

| Year. | Number of producers. | Ore. | Gold.[a] | Silver.[a] | Copper. | Lead. | Total value. |
|---|---|---|---|---|---|---|---|
| | | *Short tons.* | | *Fine ounces.* | *Pounds.* | *Pounds.* | |
| 1921 | 16 | 929,455 | $2,645 | 2,247 | 20,332,938 | 30,166 | $2,629,199 |
| 1922 | 36 | 1,345,612 | 6,718 | 20,145 | 27,126,834 | 275,209 | 3,704,122 |
| Increase, 1922 | 20 | 416,157 | 4,073 | 17,898 | 6,793,896 | 245,043 | 1,074,923 |

[a] Includes placer production.

The value of all metals produced in Pima County increased in 1922, and the largest increase was in the output of copper from the low-grade disseminated ores produced in the Ajo district and treated by leaching. Ore of shipping grade aggregated 5,457 tons, valued at $112,897, or $20.69 a ton. At milling plants 302 tons of ore yielded gold and silver bullion having a total value of $2,160. The placer output amounted to $2,875 in gold and 31 ounces of silver.

*Ajo district.*—During 1922 the New Cornelia mine [13] was the only producer in the Ajo district. Most of the ore was dug by steam shovel from the open pit and treated in the 5,000-ton acid leaching plant on the property. The production of copper was curtailed the first

[13] New Cornelia Copper Co. Ann. Rept. for year ending Dec. 31, 1922.

six months of the year, but the accumulated surplus from 1921 was gradually decreased as the market for copper improved. Production was increased the last half of 1922 to about 3,000,000 pounds a month. The output of copper amounted to 26,612,803 pounds, of which 26,408,610 pounds was electrolytic copper, 140,732 pounds was cement copper, and 63,461 pounds was contained in high-grade copper ore. Sales of copper in 1922 amounted to 46,306,366 pounds, at an average price of 13.39 cents a pound. Dividends paid to stockholders since 1918 amount to $3,150,000, of which $1,800,000 was paid in 1922. The company's annual report contains the following paragraphs:

In August production of ore at the mines was increased from 2,500 tons per day to 5,000 tons. Copper production for the first seven months of the year was at the rate of approximately 1,600,000 pounds per month. The production for the last four months of the year averaged slightly under 3,200,000 pounds per month. The pounds costs which have been secured by the Ajo organization after the increase in production was authorized have been most gratifying. In spite of the fact that taxes and freight rates are still very high and that we pay from 25 to 75 per cent over pre-war prices for most of our supplies, the costs for this period were lower than for any other period in the history of the company. * * *

The matter of outstanding importance in the year's operations was the approval of the board of directors of an appropriation covering the construction of a 5,000-ton flotation mill for the treatment of sulphide ores. * * * Work was started in the field in October. * * * It is anticipated that the mill will be complete and ready for operation in December of 1923.

In anticipation of the additional water required for the operation of the mill, a second shaft was sunk in the vicinity of the present water shaft, to a depth of 656 feet, and drifting is being done to insure an adequate water supply. * * *

The carbonate ore reserves will permit the operation of our leaching plant for a period of approximately three and a half years, and possibly for a slightly longer period. An additional 5,000-ton unit will at that time probably be added to the new flotation mill. * * *

There were mined and delivered to the crushing plants during the year 1,339,757 tons of ore, averaging 1.411 per cent total copper, and shipped to the Douglas smelter 851.3 tons of ore, averaging 3.781 per cent copper. The soluble copper in the ore sent to the leaching tanks averaged 1.254 per cent; insoluble copper 0.157 per cent. The insoluble-copper content has increased over the ore produced in 1921 by 0.025 per cent. The increase in the insoluble-copper content in the ore is caused by our mining at the contact between the carbonate and sulphide ore bodies, which are now exposed in several places in the mine. * * *

In the sulphurous plant the crushers and Wedge furnaces, crushing and roasting Bisbee sulphide ores, have operated satisfactorily. The crushers are to be given a general overhauling early the coming year. The reduction towers have operated satisfactorily. It will be necessary to replace one of the large wooden towers some time the coming year, as the outside staves on these towers are in a more or less rotted condition. The estimated absorption of sulphurous acid gas in these towers was 97.8 per cent.

In the electrolytic plant the lead anodes have not shown much additional corrosion after another year of service. It was necessary during the latter part of the year to put in new rubber insulators on the bus bars throughout the tank house.

*Amole district.*—The ore mined in the Amole district in 1922, amounting to 288 tons, contained $1,178 in gold, 2,325 ounces of silver, 9,078 pounds of copper, and 24,920 pounds of lead, valued in all at $6,100, or $21.18 a ton. The Ivy May group of the Arizona Tucson Copper Co. produced lead ore and copper ore containing considerable gold and silver. This property is in the prospecting stage and is opened by a 225-foot inclined shaft. About 300 feet of drifting was done, and some diamond drilling was reported. From the Helpmate claim a little siliceous silver ore containing copper and lead was taken out in development work. At the Snyder Hill claim silver-lead ore was produced.

*Arivaca district.*—Gold bullion and concentrates were recovered from ore mined from the Rosebud claim by the Oreona Development Co., which owns a reduction plant equipped for amalgamation and concentration.

*Cababi district (Comobabi).*—Three producers in the Cababi district reported a small production. The ore produced from the Little Mary group was the richest.

*Empire district.*—Seven producers in the Empire district reported the shipment of 746 tons of ore, containing $620 in gold, 7,988 ounces of silver, 9,310 pounds of copper, and 179,188 pounds of lead, valued in all at $19,720, or $26.43 a ton. Lead-silver ore, containing a little copper, was shipped from the Forty-nine, Jerome No. 2, and Red Cloud claims. From the Total Wreck mine several cars of oxidized lead ore were shipped to El Paso, Tex.

*Helvetia district.*—Development work was continued in the Rosemont mine, and considerable oxidized copper ore containing silver was shipped to El Paso, Tex.

*Pima district (Olive, San Xavier, Twin Buttes).*—From the property of the Midland Copper Co. four cars of surface ore, containing copper and a little silver, that had been mined in 1920, were shipped to El Paso, Tex., in 1922. The mine has been under water since 1920, but the work of unwatering it has been going on since August.

*Silver Bell district.*—Development work was done on the Indiana Arizona group of claims, in the course of which copper-lead ore containing a little silver was shipped. Water was pumped from the Kurtz shaft of the El Tiro mine from September 16 to November 20, and shipments of copper ore were made from October 24 to the end of the year. Considerable oxidized copper ore was shipped from the Imperial mine to the Hayden smelter.

## PINAL COUNTY.

*Mine production of gold, silver, copper, and lead in Pinal County, Ariz., in 1921 and 1922.*

| Year. | Number of producers. | Ore. | Gold.[a] | Silver.[a] | Copper. | Lead. | Total value. |
|---|---|---|---|---|---|---|---|
| | | *Short tons.* | | *Fine ounces.* | *Pounds.* | *Pounds.* | |
| 1921 | 16 | 430,943 | $23,584 | 108,078 | 12,388,772 | 96,191 | $1,734,143 |
| 1922 | 33 | 1,198,313 | 11,218 | 62,841 | 28,037,446 | 24,902 | 3,860,484 |
| Increase or decrease, 1922 | +17 | +767,370 | −12,366 | −45,237 | +15,648,674 | −71,289 | +2,126,341 |

[a] Includes placer production.

Most of the ore produced in Pinal County came from the mines at Ray. Nearly all of it, or 1,189,140 tons, was of concentrating grade and produced 89,661 tons of concentrates, mostly copper. Only a small quantity of siliceous concentrate was shipped. The ores of smelting grade aggregated 9,123 tons. A small amount of placer bullion was reported by two operators in 1922.

*Bunker Hill district (Copper Creek).*—Six producers in the Bunker Hill district reported the output of 114 tons of ore, containing $73 in gold, 3,540 ounces of silver, 19,554 pounds of copper, and 18,769 pounds of lead, valued in all at $7,285, or $63.90 a ton. This output

represented the work of lessees on several properties, among which were the Figueroa, Rough Rider, and Fortuna.

*Casa Grande district.*—The Vekol Leasing Co. hauled its product 40 miles northeast to Casa Grande, a station on the Southern Pacific Railroad. The ore shipped contained principally silver with a little lead and copper. This property is opened by two vertical shafts 500 feet deep and has many miles of drifts.

*Cottonwood district.*—A car of silver ore containing gold was shipped by the Silver Queen Mining Co., whose property is 9 miles south of Winkelman.

*Mineral Creek district (Ray, Kelvin).*—Five producers in the Mineral Creek district reported 1,196,809 tons of ore in 1922, compared with 408,588 tons in 1921. Most of the ore came from the Ray Consolidated property and was treated in the concentration mill at Hayden. The remainder came from mining prospects and represented small shipments of either copper ore or lead ore.

After a year of complete idleness the Ray Consolidated mine and mill resumed operations early in April.[14] Shipments of concentrating ore from the mine to the mill at Hayden amounted to 1,181,455 tons, averaging 1.59 per cent of copper, and 7,680 tons of fluxing ore, averaging 2.81 per cent of copper, was shipped directly to the smelter. The operating mining cost for the year was 99 cents a ton, compared with $1.31 for 1921, and the milling cost, excluding charge for depreciation, for which there was no cash outlay, was 83 cents a ton, compared with $1.22 a ton for 1921 similarly computed. The total amount of ore milled from the beginning of operations to the end of 1922 was 25,106,650 tons, averaging 1.67 per cent of copper. It is interesting to note that the total dividends paid to stockholders have amounted to $25,412,620.67, which is slightly in excess of $1 a ton of ore produced. The company's annual report continues as follows:

> The net production for the year, after allowing for smelter deductions, was 27,953,408 pounds of copper, as compared with 10,110,131 pounds and 47,062,030 pounds for the years 1921 and 1920, respectively, and to 88,582,649 pounds for the year 1917, when operating at practically normal capacity.
>
> The average operating cost per pound of net copper produced from milling and from direct smelting ore for the year was 12.41 cents, as compared with a cost of 16.25 cents for the previous year. This cost takes into account credits for the value of gold and silver and miscellaneous income. The costs stated include all operating and general expenses of every nature, except depreciation, which is carried as a charge against income at the end of the year. They also include the usual charge to cover extinguishment of mine-development expenditures, which amounts to 15 cents per ton of ore milled and smelted.

*Old Hat district.*—The Oracle mine was operated by a lessee who shipped lead ore containing gold and silver.

*Pioneer district (Superior).*—The output of 35 tons of ore produced by four operators in the Pioneer district was valued at $3,122, or $89.20 a ton. In the course of development work on the old Pioneer claims some silver ore was shipped, and a small quantity of copper ore was mined from the White Elephant claim. No ore was shipped from the Magma property,[15] but in the course of development work 355 tons of direct smelting ore, containing 12.63 per cent of copper and 6.73 ounces of silver and 0.074 ounce of gold to the ton, was

[14] Ray Consolidated Copper Co. Fourteenth Ann. Rept., for year ending Dec. 31, 1922.
[15] Magma Copper Co. Ann. Rept. for year ending Dec. 31, 1922.

stored in the ore bins on the surface. The milling ore, of which 635 tons was stored, contained 3.9 per cent of copper and 2.6 ounces of silver and 0.03 ounce of gold to the ton. By December the Magma Copper Co. had changed 29 miles of its narrow-gage railroad between Magma Junction, on the Arizona Eastern Railroad, and Superior to a standard-gage road. The capacity of the concentration mill was increased to 600 tons a day, and the construction of a 700-ton copper smelting plant was begun.

*Priorwood district.*—A little copper ore was shipped from the Soldier Boy property, operated by the Antelope Peak Copper Co.

*Riverside district.*—In the course of assessment work some copper ore was shipped from the Troy Arizona property.

*Saddle Mountain district.*—The Adjust Mining Co., operating the old Odell group, reported the shipment of considerable silver ore containing a little lead, copper, and gold to the El Paso and Hayden smelters in 1922. A little silver ore was also shipped from the Lawrence claim, 3 miles from Christmas, on Deer Creek. The Little Treasure claim, in the same vicinity, produced a little silver ore taken out in development work.

*Summit district.*—From the property of the Virginia Arizona Copper Co. in the Summit district, which extends into Gila County, a lot of copper ore containing silver was shipped to the smelter at Miami. This property and the Fuhrmann group are about 10 miles from Miami. Hauling the ore by autotrucks may be facilitated when the roads to the district are completed.

## SANTA CRUZ COUNTY.

Twenty-nine producers in Santa Cruz County reported an output of 3,493 tons of ore in 1922, or 2,450 tons more than was reported by 16 producers in 1921. Ore of shipping grade amounted to 2,716 tons, valued at $100,714, or $37.08 a ton. At milling plants 22 tons of lead concentrate containing silver and copper was made, valued at $1,444, or $65.64 a ton.

*Harshaw district.*—Silver ore from the Black Eagle mine, the largest producer in the Harshaw district in 1922, was shipped to Douglas and El Paso. The mine is 10 miles from Patagonia, a shipping station on the Southern Pacific Railroad. Old tailing containing silver and a little copper was shipped to the smelter from the Blue Nose property.

*Oro Blanco district.*—Silver ore mined from the Progressive claims was treated in a cyanidation plant near the property. From the Austerlitz mine a little copper ore containing gold and silver was shipped to the smelter.

*Palmetto district.*—From the Denver, Hassayampa, and Black Beauty claims lead ore was shipped to the smelter at El Paso, Tex.

*Patagonia district (Washington, Duquesne).*—Seven producers in the Patagonia district reported the output of 1,715 tons of ore, all of which, with the exception of 8 tons, was of shipping grade. The ore contained $765 in gold, 14,951 ounces of silver, 115,853 pounds of copper, and 457,881 pounds of lead, valued in all at $56,539, or $32.97 a ton. Most of the ore mined from the Kansas and New York claims, in the Washington camp, was hauled 8 miles southeast through the port of Lochiel in bond to Zorilla, Sonora, Mexico, on the Southern Pacific Railroad, and shipped to El Paso, Tex., through the port of Naco. The ore contained principally lead, copper, and

silver and is reported to have been mined from lenses in the limestone. The property is opened by a vertical shaft 200 feet deep. Lead ore was also shipped from the Mowry mine, and some gold ore from the Goodenough property was treated in an arrastre. Copper ore containing silver was mined from the Thessalia, Morning Glory, and Santa Nino properties. The producers found it possible to haul some of the copper ore to Patagonia for shipment, but most of it was shipped over the Mexican border and back through the port of Naco to Douglas.

*Tyndall district (Aztec).*—Nine producers in the Tyndall district reported an output of 505 tons of ore, containing $1,798 in gold, 13,252 ounces of silver, 29,269 pounds of copper, and 138,722 pounds of lead, valued in all at $26,631, or $52.73 a ton. Most of the output came from mining claims on the Bacca Float land grant. The producing properties were the True, Bland, Apache, Silver Hill, Alto, Eureka, Royal Blue, Jefferson, and Montezuma claims.

*Wrightson district.*—Lead concentrate carrying silver was recovered from ore mined from the Draga Z. claim. A small lot of lead ore of shipping grade was also sent to the smelter from an unnamed prospect in the Wrightson district.

## YAVAPAI COUNTY.

*Mine production of gold, silver, copper, and lead in Yavapai County, Ariz., in 1921 and 1922.*

| Year. | Number of producers. | Ore. | Gold.[a] | Silver.[a] | Copper. | Lead. | Total value. |
|---|---|---|---|---|---|---|---|
| | | *Short tons.* | | *Fine ounces.* | *Pounds.* | *Pounds.* | |
| 1921 | 51 | 191,964 | $112,984 | 383,193 | 26,576,298 | 172,150 | $3,932,266 |
| 1922 | 83 | 601,389 | 464,101 | 949,331 | 76,607,502 | 82,199 | 11,759,966 |
| Increase or decrease, 1922 | +32 | +409,425 | +351,117 | +566,138 | +50,031,204 | −89,951 | +7,827,700 |

[a] Includes placer production.

The total value of the metals reported from Yavapai County included, besides gold, $949,331 for silver, $10,342,013 for copper, and $4,521 for lead. No zinc was reported in 1922. Most of the first-class ore shipped to smelters consisted of copper ore—577,988 tons, of which 536,693 tons was sulphide. The average value of the smelting ore was $20.01 a ton. Concentrates amounting to 1,575 tons, derived from 9,360 tons of ore, were valued at $77,467, or $49.19 a ton. The placer output was $5,777 in gold and 58 ounces of silver, against $5,855 in gold and 36 ounces of silver in 1921.

*Agua Fria district.*—From three properties in the Agua Fria district 352 tons of ore was shipped to the smelter. This ore contained $2,119 in gold, 1,273 ounces of silver, and 5,088 pounds of copper, valued in all at $4,079, or $11.59 a ton. The Southwest Metals Co., owning the smelter at Humboldt, leased the Iron King mine a short time and shipped silver ore containing gold and a little copper. Shipments of ore from two other properties were also made to Humboldt by prospectors.

*Big Bug district.*—Fifteen deep mines and three placers in the Big Bug district produced 26,571 tons of ore, $29,128 in gold, 54,862 ounces of silver, 1,529,984 pounds of copper, and 80,599 pounds of lead, valued in all at $294,971. The ore was valued at $10.97 a ton. The shipping ore—17,181 tons—contained 1,135.91 ounces of gold, 28,072 ounces of silver, and 1,202,132 pounds of copper. At concentration mills 9,360 tons of ore was treated which produced 1,565 tons of concentrates, containing 86.15 ounces of gold, 26,749 ounces of silver, 327,852 pounds of copper, and 80,599 pounds of lead. Copper concentrates were shipped to Humboldt, and lead concentrates to El Paso, Tex. Only 30 tons of ore was treated by amalgamation, from which a little gold bullion was recovered. Most of the ore mined in the district came from the Blue Bell property. Part of it was reduced to concentrate, which, with the crude ore, was smelted in the furnaces of the Humboldt smelter. The Arizona National mine was leased to the Atlas Mining Co., which produced lead-silver concentrate containing a little copper. Shipments of copper ore were made to the smelter from the Gladstone & McCabe, Union group, and Copper Bar properties. Copper-lead ore from the Lookout mine at McCabe was concentrated and the product shipped to El Paso, Tex.

In June the Southwest Metals Co., the new owner of the smelting works at Humboldt, started operations, and by December it was receiving about 400 tons of ore and concentrates a day. The Blue Bell mine, in the Big Bug district, supplied daily about 250 tons of 3 per cent copper ore, largely sulphide. The Swansea lease, in Yuma County, shipped about 400 tons of concentrate a month. Shipments of silver ore from the Randsburg district, in California, and tailing from the Pioche district, in Nevada, together with custom ore from about fifty other sources, were reported. The furnaces of the Humboldt plant produce about 1,000,000 pounds of copper bullion monthly.

*Black Canyon district.*—Seven producers in the Black Canyon district reported the output of 129 tons of ore, containing $1,130 in gold, 4,619 ounces of silver, and 383 pounds of copper, valued in all at $5,801, or $44.97 a ton. A little silver ore from the Brooks claim was taken out in the course of development work, and gold-silver ore was produced from the Golden Belt, Cutter, and Gloriana properties. The Howard silver property, on which a small concentration-flotation mill is to be installed, produced a test lot of silver ore, which was smelted.

*Black Hills district.*—Development operations were carried on by the Shannon Copper Co. on its Yaeger Canyon property, and one lot of ore was shipped. About 800 tons of copper-silver ore was shipped to the Humboldt smelter from the stock pile that had been made in 1921. According to the mine managers the equipment on the Yaeger Canyon property has been dismantled and all work discontinued.

*Eureka district.*—From Burro Creek, in the vicinity of Bagdad and other gulches in the Eureka district, placer miners reported a little gold bullion.

*Hassayampa district.*—During 1922 only 50 tons of ore was mined from seven properties in the Hassayampa district. This ore contained gold, silver, and a little copper and was valued at $2,682, or $53.64 a ton. The chief producing claims were the Venezia, Dos Oris, Cornucopia, and Sunset.

*Martinez district.*—Lessees on the Congress mine cleaned up several hundred tons of gold ore, which was smelted.

*Peck district.*—Silver ore from the Swastika, Jack on the Green, and Blue Bird properties comprised the total output of the Peck district, which was shipped to Humboldt for smelting

*Pine Grove district.*—From the Ginger, Blue Jacket, and Del Pasco mining claims gold and silver ore was shipped to the Humboldt smelter.

*Thumb Butte district.*—A little silver ore was mined from the Dearing claim and shipped to the Humboldt smelter.

*Tiger district (Crown King, Harrington).*—Six producers in the Tiger district reported the output of 136 tons of ore, containing $470 in gold, 8,356 ounces of silver, and 500 pounds of copper, valued in all at $8,893, or $65.39 a ton. This output was derived mostly from the Cougar, Lida, and Red Cross mining claims.

*Turkey district.*—Nine producers in the Turkey district reported the production of 310 tons of ore, all of which was of shipping grade. Lead ore produced from the War Eagle claim was shipped to El Paso, Tex., and all the silver ore, containing a little copper, was shipped to Humboldt. The claims producing silver ore were the Buckeye, Juniper, Secundus, Goodwin, French Lily, and Trinity.

*Verde district (Jerome).*—The ore mined from three properties in the Verde district amounted to 572,246 tons, all of which, with the exception of 10,596 tons leached, was directly smelted. The total output contained $420,560 in gold, 843,151 ounces of silver, and 74,793,982 pounds of copper, valued in all at $11,360,899, or $19.85 a ton. Most of this output came from the United Verde and United Verde Extension mines. Silver ore was shipped to Humboldt and Clemenceau from the Copper Chief property, which is equipped with a 125-ton concentration plant, not operated in 1922.

For the ten months during which the United Verde Extension mine [16] was operated 136,980 dry tons of ore yielded at its smelter bullion containing 31,640,714 pounds of copper, 5,788 ounces of gold, and 238,764 ounces of silver. The company did 7,968 feet of development work during the year, most of which was on or above the 1,500-foot level. On the 900-foot level a large vein of gold ore worth $15 to $20 a ton was being opened. The amount of ore developed above the 1,600-foot level is estimated at 1,036,166 tons, averaging 9.7 per cent of copper and 0.03 ounce of gold and 2 ounces of silver to the ton. The cost of mining was 2.32 cents a pound of copper produced; smelting, 2.26 cents; freight on ore, 0.07 cent; freight on bullion, refining, and selling, 2.11 cents; and other expenses, 0.17 cent—a total of 6.93 cents. Dividends paid to stockholders amounted to $1,312,500.

At Clarkdale the United Verde Copper smelter started operations in June and began the production of copper in July at the rate of 5,000,000 pounds a month. In August the company completed preparations for heap leaching the low-grade ore, which promises to add materially to the future copper output. Shipments from the newly opened oxide ore, which is mined by steam shovel, were made at the rate of about 1,500 tons a week. The high-grade siliceous ore that occurs above the oxide ore is also mined and shipped.

[16] United Verde Extension Mining Co. Ann. Rept. for year ending Dec. 31, 1922.

*Walker district* (*Lynx Creek*).—Two mine operators in the Walker district mined from the Blue John & Wedge and Sheldon properties several lots of gold ore and copper ore. The output of these two properties was valued at $2,035, or $14.64 a ton, and part of it was recovered as gold bullion. The placer output reported by five producers amounted to $1,206 in gold and 19 ounces of silver, valued together at $1,225. The Sheldon Mining Co. started in July to repair the Poland tunnel, 8,500 feet long, which makes connection with the camp of Poland. This tunnel had not been used for years, and many caves had occurred. Its use will lessen the haul from the mine to the smelter at Humboldt.

*Weaver district* (*Octave*).—From the St. Elmo claim ore was treated by amalgamation in a 10-stamp mill, and from the Monte Cristo dump old tailings produced some 20 years ago were cyanided. The output, including that of four placer producers, amounted to $1,301 in gold and silver. Most of the placer gold was found in the vicinity of the Stanton mine and Antelope Gulch.

## YUMA COUNTY.

The total value of the gold, silver, and copper produced in Yuma County was $514,048, against $27,822 in 1921. The lead output in 1921 was valued at $1,741, but none was produced in 1922. The placer production was valued at $642.

*Cienega district.*—A 300-ton acid leaching plant was under construction in August on the property of the Arizona Standard Copper Co., 14 miles east of Parker. Considerable copper ore is said to be developed in the property.

*Ellsworth district.*—Six producers in the Ellsworth district reported the production of 657 tons of ore, of which 580 tons was treated in gold and silver mills and 77 tons was shipped directly to smelters. The output of the district was valued at $14, 291, most of which was gold bullion from the Harqua Hala property. The Apache Chief, Knob Hill, and one other property produced copper ore containing silver.

*Planet district* (*Swansea*).—Considerable mining activity was noted at the Signal mine, operated by the Swansea Lease (Inc.). Copper ore of milling grade was treated in a concentration-flotation mill at Swansea. Several thousand tons of first-class copper ore, together with a large quantity of concentrate, was shipped to the Humboldt smelter for treatment. The property, now owned by the Southwest Metals Co., is reported to have in reserve about 100, 000 tons of ore containing 4.5 per cent of copper. All the output in 1922 was sulphide ore in a basic gangue, with the minerals chalcopyrite and specularite. The property is opened by a vertical shaft 700 feet deep, with drifts and crosscuts.

*Plomosa district.*—The Arizona Operating Co. reported development work on the Copper Bottoms property during 1922 and expected to continue the work in 1923 by diamond drilling. The company owns an 8-ton ball mill and a Stebbins dry-concentrating table and is therefore equipped to make any necessary ore tests. Development work consisted of 800 feet of tunneling and 125 feet of shaft work in 1922. The output of placers amounted to $297 in gold.

# GOLD, SILVER, COPPER, LEAD, AND ZINC IN COLORADO.

(MINES REPORT.)

By Charles W. Henderson.

## PRODUCTION.

### SUMMARY.

The total calculated gross value of the gold, silver, copper, lead, and zinc produced in Colorado in 1922 showed an increase of 9 per cent over the gross value in 1921. Appreciable increases in silver and lead and a marked increase in zinc more than counterbalanced the decreases in gold and copper.

*Mine production of gold, silver, copper, lead, and zinc in Colorado in 1921–22.*

| Year. | Number of producing mines. | Ore. | Gold. | | Silver.[b] | Copper. | Lead. | Zinc. | Total value. |
|---|---|---|---|---|---|---|---|---|---|
| | | | Placer. | Deep. | | | | | |
| | | *Short tons.* | | | *Fine ounces.* | *Pounds.* | *Pounds.* | *Pounds.* | |
| 1921 | 382 | 1,281,381 | $344,640 | $6,490,688 | 5,631,657 | 4,153,442 | 19,660,466 | 2,360,000 | $14,005,500 |
| 1922 | 480 | 1,412,100 | 356,403 | 6,017,016 | 5,855,911 | 3,373,454 | 23,477,200 | 23,258,000 | 15,301,698 |
| Increase or decrease, 1922 | +98 | +130,719 | +11,763 | −473,672 | +224,254 | −779,988 | +3,816,734 | +20,898,000 | +1,296,198 |

[a] A revised table showing the production of gold, silver, copper, lead, and zinc from the beginning of mining in Colorado to 1922 will be included in a professional paper, "Mining in Colorado," now in preparation.

[b] Includes placer production.

### ORE.

In 1922 amalgamating and cyaniding mills with concentrating equipment treated 849,261 tons of ore, from which were recovered in bullion and cyanide precipitates 217,548.64 fine ounces of gold, 41,405 fine ounces of silver, and 33,561 tons of concentrates. These concentrates contained 36,404.52 fine ounces of gold, 2,066,166 fine ounces of silver, 604,179 pounds of copper, and 5,947,241 pounds of lead. The average recovery per ton of ore treated was 0.299 ounce of gold and 2.4817 ounces of silver. A total of 302,232 tons of ore went directly to concentrating mills and yielded 26,729 tons of concentrates, or at a ratio of 11 to 1. From these concentrates were recovered 6,262.90 fine ounces of gold, 1,070,070 fine ounces of silver,

162,904 pounds of copper, 6,280,198 pounds of lead, and 1,100,000 pounds of zinc. The lead concentrates, amounting to 50,451 tons, contained 12,173,303 pounds of lead; 39,836 tons in 1921 contained 10,225,992 pounds. The concentrates of all other classes contained only small quantities of lead. The smelting ores contained 11,249,761 pounds of lead, as compared with 9,236,055 pounds in 1921 and 17,586,661 pounds in 1920.

### GOLD.

The mine production of gold was 308,314.15 fine ounces, valued at $6,373,419, a decrease of 22,344.84 fine ounces and of $461,909 in value, following decreases of $740,991 in 1921, of $2,310,308 in 1920, and of $2,865,091 in 1919.

The Cripple Creek district had the smallest output since 1894 but contributed more than 63 per cent of the total yield. That part of the San Juan region including Dolores, La Plata, Ouray, San Juan, and San Miguel counties yielded $1,263,779, a decrease of $333,579. There were increases of $2,995 in Boulder County, $7,388 in Eagle, $12,110 in Gilpin, $103,914 in Lake, $52,731 in Ouray, $100,870 in Park, $2,993 in Saguache, and $17,487 in San Juan, and decreases of $12,098 in Chaffee County, $2,652 in Clear Creek, $9,043 in Gunnison, $12,920 in La Plata, $390,974 in San Miguel, $77,068 in Summit, and $254,301 in Teller.

The output of placer gold in 1922 was $356,403, an increase of $11,763. Summit County, with three dredges, one sluice mine, and three hydraulic mines, produced nearly 72 per cent of the placer gold, and Park County produced nearly 28 per cent. Other placer producing counties were Adams, Douglas, Gilpin, Moffat, Montrose, and Lake.

### SILVER.

The output of silver was valued at $5,855,911, an increase of $224,254. The greatest increases in production were made in Clear Creek, Ouray, and Pitkin counties.

### COPPER.

The output of copper was valued at $455,416, a decrease of $80,378. Eagle County produced 39 per cent of the copper output, Lake County 26 per cent, and San Miguel 20 per cent.

### LEAD.

The lead produced, reckoned as lead in lead bullion and in leaded zinc oxide, was valued at $1,291,246, an increase of $406,525. There were increases in value in all the important lead-producing counties. San Miguel County was the first in rank and was followed in order by Lake, Pitkin, San Juan, and Ouray.

### ZINC.

The zinc ores marketed contained recoverable zinc valued at $1,325,706, an increase of $1,207,706. Eagle County produced 47 per cent of the zinc output of the State, as compared with no production for 1921. Lake County produced 9,003,000 pounds, or 39

per cent, in 1922, as against 1,821,000 pounds, or 77 per cent, in 1921. Other producing counties were San Juan, Summit, Clear Creek, and Chaffee.

*Zinc and lead-zinc ore and concentrates as marketed at the mine or mill in Colorado in 1922.*

| County. | Classification. | Short tons. | Estimated recoverable zinc. | Zinc content. | Average assay of zinc. | Average wet assay of lead. |
|---|---|---|---|---|---|---|
| | | | *Pounds.* | *Pounds.* | *Per cent.* | *Per cent.* |
| Chaffee and Lake | Zinc oxidized ore | 11,707 | 4,054,000 | 5,067,283 | 21.64 | ..... |
| Lake | Zinc-lead sulphide ore | 10,513 | 5,127,000 | 6,408,013 | 30.48 | 5.38 |
| Clear Creek, Eagle, San Juan, and Summit. | Zinc sulphide ore and zinc concentrates. | 35,156 | 14,077,000 | 19,042,172 | 27.08 | ..... |
| | | 57,376 | 23,258,000 | 30,517,468 | 26.59 | ..... |

## OUTPUT OF ORE AND METAL CONTENT.

*Ores and metals produced in Colorado in 1922.*

| Source of production. | Ore. | | Gold. | | Silver. | |
|---|---|---|---|---|---|---|
| | Short tons. | Per cent. | Fine ounces. | Per cent. | Fine ounces. | Per cent. |
| Dry gold ore | 449,658 | 31.84 | 217,606.90 | 70.58 | 73,191 | 1.25 |
| Dry gold and silver ore | 397,191 | 28.13 | 58,192.31 | 18.87 | 1,756,858 | 30.00 |
| Dry silver ore | 449,652 | 31.84 | 10,421.10 | 3.38 | 3,418,709 | 58.38 |
| | 1,296,501 | 91.81 | 286,220.31 | 92.83 | 5,248,758 | 89.63 |
| Copper ore | 863 | .06 | 556.47 | .18 | 31,463 | .54 |
| Copper-lead ore | 627 | .04 | 84.47 | .03 | 37,418 | .64 |
| Lead ore | 48,381 | 3.43 | 3,906.13 | 1.27 | 493,697 | 8.43 |
| Lead-zinc ore | 22,113 | 1.57 | 304.57 | .10 | 40,056 | .68 |
| Zinc ore | 43,615 | 3.09 | 1.20 | ..... | 291 | .01 |
| | 115,599 | 8.19 | 4,852.84 | 1.58 | 602,925 | 10.30 |
| Total deep mines | 1,412,100 | 100.00 | 291,073.15 | 94.41 | 5,851,683 | 99.93 |
| Total placers | ..... | ..... | 17,241.00 | 5.59 | 4,228 | .07 |
| Total, deep mines and placers, 1922 | 1,412,100 | 100.00 | 308,314.15 | 100.00 | 5,855,911 | 100.00 |
| Total, deep mines and placers, 1921 | 1,281,381 | ..... | 330,658.99 | ..... | 5,631,657 | ..... |
| Increase or decrease, 1922 | +130,719 | ..... | −22,344.84 | ..... | +224,254 | ..... |

| Source of production. | Copper. | | Lead. | | Zinc. | |
|---|---|---|---|---|---|---|
| | Pounds. | Per cent. | Pounds | Per cent. | Pounds. | Per cent. |
| Dry gold ore | 57,478 | 1.71 | 176,202 | .75 | ..... | ..... |
| Dry gold and silver ore | 1,053,975 | 31.24 | 7,223,125 | 30.77 | ..... | ..... |
| Dry silver ore | 1,917,436 | 56.84 | 7,162,729 | 30.51 | ..... | ..... |
| | 3,028,889 | 89.79 | 14,562,056 | 62.03 | ..... | ..... |
| Copper ore | 105,864 | 3.14 | 18,575 | .08 | ..... | ..... |
| Copper-lead ore | 60,299 | 1.79 | 162,646 | .69 | ..... | ..... |
| Lead ore | 141,082 | 4.18 | 7,062,288 | 30.08 | ..... | ..... |
| Lead-zinc ore | 37,320 | 1.10 | 1,660,135 | 7.07 | 7,527,000 | 32.36 |
| Zinc ore | ..... | ..... | 11,500 | .05 | 15,731,000 | 67.64 |
| | 344,565 | 10.21 | 8,915,144 | 37.97 | 23,258,000 | 100.00 |
| Total deep mines, 1922 | 3,373,454 | 100.00 | 23,477,200 | 100.00 | 23,258,000 | 100.00 |
| Total deep mines, 1921 | 4,153,442 | ..... | 19,660,466 | ..... | 2,360,000 | ..... |
| Increase or decrease, 1922 | −779,988 | ..... | +3,816,734 | ..... | +20,898,000 | ..... |

*Placer output in Colorado in 1922, in fine ounces.*

| County. | Sluicing and hydraulic. | | Dredges. | | Total. | |
|---|---|---|---|---|---|---|
| | Gold. | Silver. | Gold. | Silver. | Gold. | Silver. |
| Adams | 24.09 | 4 | | | 24.09 | 4 |
| Douglas | .58 | | | | .58 | |
| Gilpin | 18.29 | 3 | | | 18.29 | 3 |
| Lake | 15.24 | | | | 15.24 | |
| Moffat | 5.51 | | | | 5.51 | |
| Montrose | 15.58 | 4 | | | 15.58 | 4 |
| Park | 34.54 | 8 | 777.14 | 991 | 4,811.68 | 999 |
| Summit | 373.60 | 109 | 11,976.43 | 3,109 | 12,350.03 | 3,218 |
| | 487.43 | 128 | 16,753.57 | 4,100 | 17,241.00 | 4,228 |
| Total, 1921 | 323.63 | 96 | 16,348.32 | 4,346 | 16,671.95 | 4,442 |
| Increase or decrease, 1922 | +163.80 | +32 | +405.25 | −246 | +569.05 | −214 |

*Content of ores sold or treated in Colorado in 1922.*

**Dry gold ores.**

| County. | Ore. | Gold | Silver. | Copper. | Lead. |
|---|---|---|---|---|---|
| | *Short tons.* | *Fineounces.* | *Fineounces.* | *Pounds.* | *Pounds.* |
| Boulder | 611 | 1,610.62 | 1,181 | | |
| Clear Creek | 1,323 | 711.98 | 2,009 | 2,548 | 11,660 |
| Eagle | 150 | 189.80 | 1,099 | 444 | |
| Gilpin | 4,186 | 1,861.51 | 4,025 | 8,710 | 14,388 |
| Gunnison | 21 | 78.30 | 110 | 80 | 278 |
| Lake | 3,912 | 9,852.76 | 28,070 | 37,323 | 110,454 |
| La Plata | 651 | 1,379.51 | 7,435 | | |
| Ouray | 5,000 | 2,462.55 | 724 | 5,238 | |
| Park | 497 | 2,026.71 | 1,359 | 3,135 | 39,422 |
| Saguache | 44 | 163.99 | 294 | | |
| San Juan | | 302.08 | 159 | | |
| San Miguel | 1,134 | 1,649.06 | 2,264 | | |
| Teller | 432,129 | 195,318.03 | 24,462 | | |
| | 449,658 | 217,606.90 | 73,191 | 57,478 | 176,202 |
| Total, 1921 | 495,853 | 221,292.06 | 81,157 | 54,359 | 119,140 |
| Increase or decrease, 1922 | −46,195 | −3,685.16 | −7,966 | +3,119 | +57,062 |

**Dry gold and silver ores.**

| | | | | | |
|---|---|---|---|---|---|
| Boulder | 8 | 10.25 | 187 | | |
| Chaffee | 756 | 443.70 | 5,346 | 2,143 | 47,727 |
| Clear Creek | 5,540 | 751.62 | 24,188 | 935 | 389,876 |
| Eagle | 88 | 40.80 | 1,174 | 2,500 | |
| Gilpin | 255 | 144.31 | 2,509 | 1,295 | 2,475 |
| Gunnison | 137 | 216.28 | 1,908 | | 3,461 |
| Lake | 10,169 | 5,968.10 | 160,473 | 411,384 | 174,716 |
| La Plata | 84 | 176.72 | 2,195 | | |
| Ouray | 784 | 108.78 | 2,366 | 806 | 23,066 |
| San Juan | | | | | |
| San Miguel | 379,283 | 50,217.75 | 1,554,817 | 634,845 | 6,579,636 |
| Summit | 87 | 114.00 | 1,695 | 67 | 2,168 |
| | 397,191 | 58,192.31 | 1,756,858 | 1,053,975 | 7,223,125 |
| Total, 1921 | 269,087 | 53,991.30 | 589,284 | 891,660 | 3,409,026 |
| Increase, 1922 | 128,104 | 4,201.01 | 1,167,574 | 162,315 | 3,814,099 |

*Content of ores sold or treated in Colorado in 1922*—Continued.

**Dry silver ores.**

| County. | Ore. | Gold. | Silver. | Copper. | Lead. |
|---|---|---|---|---|---|
| | *Short tons.* | *Fine ounces.* | *Fine ounces.* | *Pounds.* | *Pounds.* |
| Boulder | 2,602 | 100.79 | 84,783 | ..... | 35,105 |
| Chaffee | 4,226 | 12.28 | 9,316 | 2,809 | 33,226 |
| Clear Creek | 54,006 | 70.37 | 129,796 | 734 | 207,642 |
| Custer | 52 | .50 | 1,046 | ..... | 3,815 |
| Dolores | 92 | 58.26 | 8,259 | 283 | 2,416 |
| Eagle | 40,345 | 2,985.97 | 579,847 | 1,319,435 | 322,603 |
| Gilpin | 8,678 | 72.17 | 15,396 | 1,457 | 124,627 |
| Gunnison | 16 | .90 | 849 | 112 | ..... |
| Hinsdale | 1,418 | 53.91 | 43,246 | 9,481 | 71,256 |
| Lake | 69,490 | 2,272.77 | 712,957 | 416,800 | 2,659,659 |
| La Plata | 56 | 4.40 | 1,026 | ..... | ..... |
| Mineral | 3,918 | 49.21 | 106,766 | 3,422 | 122,941 |
| Montrose | ..... | ..... | 1,767 | 16 | ..... |
| Ouray | 117,075 | 3,501.49 | 1,197,758 | 44,248 | 1,369,213 |
| Park | 63 | 13.49 | 4,755 | 878 | 1,590 |
| Pitkin | 107,847 | ..... | 345,766 | ..... | 1,800,872 |
| Routt | 1 | ..... | 82 | ..... | ..... |
| Saguache | 9,232 | 19.20 | 34,930 | 190 | 10,020 |
| San Juan | 94 | 15.24 | 4,700 | 1,229 | 4,694 |
| San Miguel | 16,838 | 150.54 | 44,069 | 23,785 | 319,544 |
| Summit | 13,603 | 1,039.61 | 91,595 | 92,557 | 73,506 |
| Total, 1921 | 449,652 | 10,421.10 | 3,418,709 | 1,917,436 | 7,162,729 |
| | 465,232 | 31,733.60 | 3,991,193 | 1,882,519 | 10,561,401 |
| Increase or decrease, 1922 | −15,580 | −21,312.50 | −572,484 | +34,917 | −3,398,672 |

**Copper ores.**[a]

| | | | | | |
|---|---|---|---|---|---|
| Chaffee | 1 | ..... | 86 | 216 | ..... |
| Clear Creek | 6 | 9.00 | 88 | 417 | 202 |
| Custer | 289 | 5.50 | 7,234 | 17,934 | 15,890 |
| Eagle | 150 | 271.80 | 1,575 | 7,917 | 44 |
| Gilpin | 71 | 198.78 | 1,466 | 7,452 | ..... |
| Lake | 12 | 34.41 | 300 | 1,088 | ..... |
| Montrose | 251 | ..... | 16,197 | 61,103 | ..... |
| Ouray | 9 | ..... | 433 | 4,006 | ..... |
| Saguache | 23 | 10.18 | 2,842 | 1,481 | 960 |
| San Juan | 17 | 1.20 | 219 | 1,103 | 1,193 |
| San Miguel | 34 | 25.60 | 1,023 | 3,147 | 286 |
| Total, 1921 | 863 | 556.47 | 31,463 | 105,864 | 18,575 |
| | 22,195 | 1,811.24 | 382,521 | 1,164,248 | 10,522 |
| Increase or decrease, 1922 | −21,332 | −1,254.77 | −351,058 | −1,058,384 | +8,053 |

[a] All smelting ore.

**Lead-copper ores.**

| | | | | | |
|---|---|---|---|---|---|
| Clear Creek | 10 | 0.44 | 337 | 824 | 4,845 |
| Custer | 187 | 1.90 | 6,101 | 14,207 | 38,086 |
| Fremont | 7 | 1.02 | 174 | 348 | 4,273 |
| Hinsdale | 41 | 3.98 | 4,206 | 3,063 | 10,819 |
| Saguache | 355 | 34.50 | 24,364 | 39,186 | 97,118 |
| San Juan | 15 | 34.10 | 1,727 | 867 | 6,169 |
| San Miguel | 12 | 8.53 | 509 | 1,804 | 1,336 |
| Total, 1921 | 627 | 84.47 | 37,418 | 60,299 | 162,646 |
| | 820 | 24.60 | 40,949 | 78,448 | 184,221 |
| Increase or decrease, 1922 | −193 | +59.87 | −3,531 | −18,149 | −21,575 |

*Content of ores sold or treated in Colorado in 1922*—Continued.

**Lead ores.**[b]

| County. | Ore. | Gold. | Silver. | Copper. | Lead. | Zinc. |
|---|---|---|---|---|---|---|
| | *Short tons.* | *Fine ounces.* | *Fine ounces.* | *Pounds.* | *Pounds.* | *Pounds.* |
| Boulder | 194 | 70.00 | 34,922 | ..... | 33,365 | ..... |
| Chaffee | 1,497 | 507.22 | 11,148 | 15,358 | 569,275 | ..... |
| Clear Creek | 732 | 173.52 | 22,863 | 1,999 | 216,876 | ..... |
| Custer | 16,684 | .18 | 139 | ..... | 602,827 | ..... |
| Dolores | 586 | 36.22 | 22,008 | 23,806 | 84,784 | ..... |
| Eagle | 1 | ..... | 42 | ..... | 171 | ..... |
| Gilpin | 517 | 206.90 | 20,511 | 5,946 | 105,455 | ..... |
| Gunnison | 47 | 148.60 | 936 | 334 | 9,643 | ..... |
| Hinsdale | 91 | 4.90 | 2,622 | 1,725 | 32,125 | ..... |
| Lake | 7,108 | 1,838.40 | 50,248 | 4,775 | 1,533,314 | ..... |
| Mineral | 60 | 30.80 | 137 | ..... | 30,514 | ..... |
| Ouray | 228 | 20.50 | 25,389 | 3,851 | 92,247 | ..... |
| Park | 560 | 23.19 | 8,415 | 202 | 114,970 | ..... |
| Pitkin | 11,176 | ..... | 179,403 | ..... | 1,754,437 | ..... |
| Saguache | 17 | 6.70 | 1,112 | 765 | 3,684 | ..... |
| San Juan | 7,004 | 631.60 | 49,969 | 70,246 | 1,336,856 | ..... |
| San Miguel | 539 | 89.32 | 42,777 | 10,286 | 160,089 | ..... |
| Summit | 1,340 | 118.08 | 21,056 | 1,789 | 381,656 | ..... |
| | 48,381 | 3,906.13 | 493,697 | 141,082 | 7,062,288 | ..... |
| Total, 1921 | 18,289 | 5,089.73 | 524,023 | 81,260 | 4,851,872 | ..... |
| Increase or decrease, 1922 | +30,092 | −1,183.60 | −30,326 | +59,822 | +2,210,416 | ..... |

[b] Nearly all smelting ore.

**Lead-zinc ores.**

| | | | | | | |
|---|---|---|---|---|---|---|
| Clear Creek, Lake, San Juan, and Summit | 22,113 | 304.57 | 40,056 | 37,320 | 1,660,135 | 7,527,000 |
| Total, 1921 | 4,178 | 30.60 | 14,851 | 948 | 456,720 | 483,000 |
| Increase, 1922 | 17,935 | 273.97 | 25,205 | 36,372 | 1,203,415 | 7,044,000 |

**Zinc ores.**

| | | | | | | |
|---|---|---|---|---|---|---|
| Chaffee, Eagle, Lake, and Summit | 43,615 | 1.20 | 291 | ..... | 11,500 | 15,731,000 |
| Total, 1921 | 5,727 | 13.91 | 3,237 | ..... | 67,564 | 1,877,000 |
| Increase or decrease, 1922 | +37,888 | −12.71 | −2,946 | ..... | −56,064 | +13,854,000 |

*Mine production of metals from gold and silver mills in Colorado in 1922.*

| County. | Ore to gold and silver mills. | Bullion. | | Concentrates. | | | | |
|---|---|---|---|---|---|---|---|---|
| | | Gold. | Silver. | Total. | Gold. | Silver. | Copper. | Lead. |
| | *Short tons.* | *Fine ounces.* | *Fine ounces.* | *Short tons.* | *Fine ounces.* | *Fine ounces.* | *Pounds.* | *Pounds.* |
| Boulder | 526 | 1,139.03 | 373 | ..... | ..... | ..... | ..... | ..... |
| Clear Creek | 138 | 23.04 | 4 | 12 | 12.83 | 45 | 118 | 211 |
| Gilpin | 3,781 | 626.02 | 190 | 277 | 455.95 | 1,853 | 4,023 | 12,934 |
| Gunnison | 32 | 64.98 | 111 | ..... | ..... | ..... | ..... | ..... |
| Lake | ..... | 2,730.77 | 750 | ..... | ..... | ..... | ..... | ..... |
| La Plata | ..... | 18.61 | 156 | ..... | ..... | ..... | ..... | ..... |
| Ouray | 74,373 | 1,686.25 | 1,020 | 5,374 | 3,551.30 | 693,434 | 5,238 | ..... |
| Pitkin | ..... | ..... | 490 | ..... | ..... | ..... | ..... | ..... |
| San Juan | ..... | 302.08 | 159 | ..... | ..... | ..... | ..... | ..... |
| San Miguel | 338,284 | 21,559.53 | 17,315 | 25,938 | 26,493.64 | 1,367,212 | 594,800 | 5,934,096 |
| Teller | 432,127 | 189,398.33 | 20,837 | 1,960 | 5,890.80 | 3,622 | ..... | ..... |
| | 849,261 | 217,548.64 | 41,405 | 33,561 | 36,404.52 | 2,066,166 | 604,179 | 5,947,241 |

Average recovery per ton in bullion and concentrates: Gold, 0.299 ounce; silver, 2.4817 ounces.

*Mine production of metals from concentrating mills in Colorado in 1922.*

| County. | Ore to concentrating mills. | Concentrates produced. | Gold. | Silver. | Copper. | Lead. | Zinc. |
|---|---|---|---|---|---|---|---|
| | *Short tons.* | *Short tons.* | *Fine ounces.* | *Fine ounces.* | *Pounds.* | *Pounds.* | *Pounds.* |
| Boulder | 950 | 48 | 1.88 | 7,295 | ..... | 34,701 | ..... |
| Chaffee | 4,000 | 100 | 2.90 | 5,787 | 2,539 | 23,017 | ..... |
| Clear Creek | 68,197 | 4,192 | 1,155.72 | 164,281 | 3,451 | 816,878 | 800,000 |
| Custer | 16,665 | 450 | ..... | ..... | ..... | 600,000 | ..... |
| Gilpin | 8,793 | 305 | 81.45 | 11,929 | 2,429 | 122,865 | ..... |
| Hinsdale | 700 | 73 | 9.00 | 2,247 | 3,657 | 47,628 | ..... |
| Ouray | 48,252 | 4,623 | 803.67 | 495,993 | 43,927 | 1,389,862 | ..... |
| Pitkin | 78,406 | 10,416 | ..... | 123,656 | ..... | 1,317,127 | ..... |
| Saguache | 9,200 | 184 | 18.50 | 31,564 | 190 | 9,673 | ..... |
| San Juan | 6,050 | 1,210 | 395.90 | 10,518 | 43,458 | 853,124 | ..... |
| San Miguel | 58,905 | 4,540 | 3,785.38 | 214,760 | 63,253 | 963,323 | ..... |
| Summit | 2,114 | 588 | 8.50 | 2,040 | ..... | 102,000 | 300,000 |
| | 302,232 | 26,729 | 6,262.90 | 1,070,070 | 162,904 | 6,280,198 | 1,100,000 |

*Mine production of metals from Colorado concentrates in 1922.*

**By counties.**

| | Concentrates. | Gold. | Silver. | Copper. | Lead. | Zinc. |
|---|---|---|---|---|---|---|
| | *Short tons.* | *Fine ounces.* | *Fine ounces.* | *Pounds.* | *Pounds.* | *Pounds.* |
| Boulder | 48 | 1.88 | 7,295 | ..... | 34,701 | ..... |
| Chaffee | 100 | 2.90 | 5,787 | 2,539 | 23,017 | ..... |
| Clear Creek | 4,204 | 1,168.55 | 164,326 | 3,569 | 817,089 | 800,000 |
| Custer | 450 | ..... | ..... | ..... | 600,000 | ..... |
| Gilpin | 582 | 537.40 | 13,782 | 6,452 | 135,799 | ..... |
| Hinsdale | 73 | 9.00 | 2,247 | 3,657 | 47,628 | ..... |
| Ouray | 9,997 | 4,354.97 | 1,189,427 | 49,165 | 1,389,862 | ..... |
| Pitkin | 10,416 | ..... | 123,656 | ..... | 1,317,127 | ..... |
| Saguache | 184 | 18.50 | 31,564 | 190 | 9,673 | ..... |
| San Juan | 1,210 | 395.90 | 10,518 | 43,458 | 853,124 | ..... |
| San Miguel | 30,478 | 30,279.02 | 1,581,972 | 658,053 | 6,897,419 | ..... |
| Summit | 588 | 8.50 | 2,040 | ..... | 102,000 | 300,000 |
| Teller | 1,960 | 5,890.80 | 3,622 | ..... | ..... | ..... |
| | 60,290 | 42,667.42 | 3,136,236 | 767,083 | 12,227,439 | 1,100,000 |
| Total, 1921 | 49,140 | 67,432.37 | 2,568,500 | 972,552 | 10,424,411 | 217,000 |
| Increase or decrease, 1922 | +11,150 | −24,764.95 | +567,736 | −205,469 | +1,803,028 | +883,000 |

**By kinds of concentrates.**

| | | | | | | |
|---|---|---|---|---|---|---|
| Dry gold | 3,226 | 8,007.04 | 6,334 | 12,163 | 3,055 | ..... |
| Dry gold and silver | 179 | 77.23 | 1,446 | ..... | 6,104 | ..... |
| Dry silver | 4,864 | 2,294.29 | 729,116 | 190 | 14,977 | ..... |
| Lead | 50,451 | 32,267.86 | 2,389,256 | 754,730 | 12,173,303 | ..... |
| Total to copper and lead plants | 58,720 | 42,646.42 | 3,126,152 | 767,083 | 12,197,439 | ..... |
| Zinc (to zinc and lead-zinc plants) | 1,570 | [a] 21.00 | [a] 10,084 | ..... | [b] 30,000 | [c] 1,100,000 |
| | 60,290 | 42,667.42 | 3,136,236 | 767,083 | 12,227,439 | 1,100,000 |

[a] Recovered in zinc residues.
[b] Lead recovered in zinc residues and leaded zinc oxide.
[c] Zinc recovered as metal and zinc in zinc oxide.

*Mine production of metals from Colorado concentrates in 1922*—Continued.

**Average content of concentrates.**

| | Gold. | Silver. | Copper. | Lead. | Zinc. |
|---|---|---|---|---|---|
| | *Fine ounces per ton.* | *Fine ounces per ton.* | *Per cent.* | *Per cent.* | *Per cent.* |
| Dry gold | 2.48 | 1.96 | 0.19 | 0.05 | ..... |
| Dry gold and silver | .43 | 8.08 | ..... | 1.71 | ..... |
| Dry silver | .47 | 149.90 | ..... | .15 | ..... |
| Lead | .64 | 47.36 | .75 | 12.06 | ..... |
| Average | .73 | 53.24 | .65 | 10.39 | ..... |
| Zinc | .01 | 6.42 | ..... | .96 | [d] 43.10 |

[d] Assay of content; no deduction for loss in smelting.

*Mine production of metals from Colorado crude ore shipped to smelters in 1922.*

**By counties.**

| | Crude ore. | Gold. | Silver. | Copper. | Lead. | Zinc. |
|---|---|---|---|---|---|---|
| | *Short tons.* | *Fine ounces.* | *Fine ounces.* | *Pounds.* | *Pounds.* | *Pounds.* |
| Boulder | 1,939 | 650.75 | 113,405 | ..... | 33,769 | ..... |
| Chaffee | 2,844 | 961.50 | 20,400 | 17,987 | 638,711 | 178,000 |
| Clear Creek | 1,090 | 559.54 | 31,877 | 4,305 | 225,402 | ..... |
| Custer | 547 | 8.08 | 14,520 | 32,141 | 60,618 | ..... |
| Dolores | 678 | 94.48 | 30,267 | 24,089 | 87,200 | ..... |
| Eagle | 71,892 | 3,488.37 | 583,737 | 1,330,296 | 322,818 | 11,000,000 |
| Fremont | 7 | 1.02 | 174 | 348 | 4,273 | ..... |
| Gilpin | 1,133 | 1,320.25 | 29,935 | 18,408 | 111,146 | ..... |
| Gunnison | 189 | 379.10 | 3,692 | 526 | 13,382 | ..... |
| Hinsdale | 850 | 53.79 | 47,827 | 10,612 | 66,572 | ..... |
| Lake | 112,547 | 17,235.67 | 951,298 | 871,370 | 5,521,818 | 9,003,000 |
| La Plata | 791 | 1,542.02 | 10,500 | ..... | ..... | ..... |
| Mineral | 3,978 | 80.01 | 106,903 | 3,422 | 153,455 | ..... |
| Montrose | 251 | ..... | 17,964 | 61,119 | ..... | ..... |
| Ouray | 471 | 52.10 | 36,223 | 8,984 | 94,664 | ..... |
| Park | 1,120 | 2,063.39 | 14,529 | 4,215 | 155,982 | ..... |
| Pitkin | 40,617 | ..... | 401,023 | ..... | 2,238,182 | ..... |
| Routt | 1 | ..... | 82 | ..... | ..... | ..... |
| Saguache | 471 | 216.07 | 31,978 | 41,432 | 102,109 | ..... |
| San Juan | 2,758 | 548.11 | 67,187 | 66,890 | 798,858 | 1,300,000 |
| San Miguel | 651 | 302.25 | 46,172 | 15,814 | 163,472 | ..... |
| Summit | 15,780 | 1,271.69 | 114,346 | 94,413 | 457,330 | 677,000 |
| Teller | 2 | 28.90 | 3 | ..... | ..... | ..... |
| | 260,607 | 30,857.09 | 2,674,042 | 2,606,371 | 11,249,761 | 22,158,000 |
| Total, 1921 | 190,348 | 27,821.84 | 3,006,144 | 3,180,890 | 9,236,055 | 2,143,000 |
| Increase or decrease, 1922 | +70,259 | +3,035.25 | −332,102 | −574,519 | +2,013,706 | +20,015,000 |

**By kinds of ore.**

| | | | | | | |
|---|---|---|---|---|---|---|
| Dry gold | 5,817 | 12,608.79 | 42,070 | 45,315 | 153,142 | ..... |
| Dry gold and silver | 11,520 | 7,191.16 | 176,461 | 417,629 | 229,921 | ..... |
| Dry silver | 160,338 | 6,644.81 | 1,882,461 | 1,842,737 | 3,722,344 | ..... |
| Copper | 863 | 556.47 | 31,463 | 105,864 | 18,575 | ..... |
| Copper-lead | 627 | 84.47 | 37,418 | 60,299 | 162,646 | ..... |
| Lead | 25,636 | 3,508.32 | 482,788 | 97,624 | 5,604,888 | ..... |
| Total to lead and copper plants | 204,801 | 30,594.02 | 2,652,661 | 2,569,468 | 9,891,516 | ..... |
| Zinc | 43,615 | 1.20 | 291 | ..... | 11,500 | 15,731,000 |
| Lead-zinc | 12,191 | 261.87 | 21,090 | 36,903 | 1,346,745 | 6,427,000 |
| Total to zinc smelters and zinc oxide plants | 55,806 | [a] 263.07 | [a] 21,381 | 36,903 | [b] 1,358,245 | [c] 22,158,000 |
| | 260,607 | 30,857.09 | 2,674,042 | 2,606,371 | 11,249,761 | 22,158,000 |

[a] Recovered in zinc residues.
[b] Lead recovered in zinc residues and leaded zinc oxide.
[c] Zinc recovered as zinc in zinc oxide.

*Mine production of metals from Colorado crude ore shipped to smelters in 1922*—Continued.

**Average content of crude ores smelted.**

| Class of ore. | Gold. | Silver. | Copper. | Lead. | Zinc. |
|---|---|---|---|---|---|
| | *Fine ounces per ton.* | *Fine ounces per ton.* | *Per cent.* | *Per cent.* | *Per cent.* |
| Dry gold | 2.17 | 7.23 | 0.39 | 1.32 | ..... |
| Dry gold and silver | .62 | 15.31 | 1.81 | 1.00 | ..... |
| Dry silver | .04 | 11.74 | .57 | 1.16 | ..... |
| Copper | .64 | 36.46 | 6.13 | 1.08 | ..... |
| Copper-lead | .13 | 59.68 | 4.81 | 12.99 | ..... |
| Lead | .14 | 18.83 | .19 | 10.93 | ..... |
| Average | .15 | 12.95 | .63 | 2.41 | ..... |
| Zinc | ..... | ..... | ..... | .013 | [d] 23.24 |
| Lead-zinc | .02 | 1.73 | .15 | 5.52 | [d] 33.00 |
| Average | .01 | .38 | .03 | 1.22 | 25.37 |

[d] Assay of content; no deduction for loss in smelting.

*Ore, slimes, and sands treated by amalgamation and cyanidation and gold and silver contained in bullion and precipitates in Colorado in 1922.*

| Process. | Material treated. | Gold in bullion. | Silver in bullion. | Quicksilver used. | Sodium cyanide used. |
|---|---|---|---|---|---|
| | *Short tons.* | *Fine ounces.* | *Fine ounces.* | *Pounds.* | *Pounds.* |
| Amalgamation | 676,134 | 91,494.84 | 24,256 | 4,711 | ..... |
| Cyanidation | [a] 432,653 | 126,053.80 | 17,149 | ..... | [b] 301,794 |
| | ..... | 217,548.64 | 41,405 | ..... | ..... |

[a] Includes crude ore treated directly by cyanidation and sands and slimes of ore treated first by amalgamation.

[b] Reduced to equivalent of 96-98 per cent content.

## METAL INDUSTRY.

The situation in the Colorado metal-mining industry during the first half of 1922 was disappointing, but there was a marked improvement as the year drew to an end, particularly in November, when the prices for lead and zinc warranted hopes of a stable market. There was also an increased interest in investigation of the industry by capitalists.

The price of $1 an ounce for silver derived from domestic ores under the Pittman Act was all that kept many Colorado mines in operation in 1922. The price of lead was low until November, and operators mining lead-silver ores depended on the silver content to carry the costs. Until November also there was hardly any market for Colorado ores. Joplin zinc concentrate was shipped into the State. Until some signs of encouragement were seen in the zinc market many operators did not feel like spending money in unwatering and cleaning up mines after long idleness. Fortunately the workings and mills of some of the zinc properties were kept in repair. Much of the zinc output for 1922, however, came from stocks accumulated from operations in 1920, or from zinc ores removed in the mining of contiguous silver ores in 1921 and 1922. The Western Zinc Oxide Co.'s furnaces at Leadville were operated steadily, and the Empire Zinc Co.'s zinc oxide plant at Canon City was reopened in August. The gold mines can hardly be said to have recovered from the depression due to war costs. Many of them remained idle, and others were worked on a small margin of profit.

Although there was very little activity around Silverton, the San Juan region as a whole made the best record for the year. San Miguel County mills, handling also products from the Humboldt mine in Ouray County, showed an increased output of silver, notwithstanding the inactivity of the Liberty Bell mine, which was closed in 1921. The production of gold decreased, however, because of the closing of this mine. The Tomboy Mines Co. (Ltd.) had fires in April and July, but reported for the fiscal year ended June 30, 1922, ore milled amounting to 211,000 tons, from which bullion and concentrates valued at $874,583 were realized, at an operating cost, not including depreciation and other costs, of $803,463. The Smuggler-Union Co. operated steadily its old 60-stamp amalgamation-concentration mill and its new 600-ton concrete and steel flotation plant. The Black Bear mine was kept in repair in preparation for the mining of the lead-zinc ore already blocked out. The ore from this mine will first be treated by the Coolbaugh process at a plant for which ground was broken in August on the Durango smelter site, adjacent to the lead furnaces. This process, developed in the Bulkley Wells Denver laboratories, is to be used for the removal of zinc from the ores of the San Juan region as a preliminary to lead smelting at Durango, which has long been hampered by the excessive zinc content of the San Juan ores. It is hoped that the cost of removing the zinc can be met by the sale of the zinc product made.

In the Atlas mine, at Sneffels, Ouray County, development of the ore reserves warranted doubling the size of the concentration-flotation mill, the results of which will be reflected in the output for 1923. The Mountain Top mine and mill were operated steadily, with greatly increased output, and the old Revenue Tunnel mine was reopened and repaired. In Hinsdale County much development work was done, and the production of silver increased materially. Mineral County (Creede) produced more than 100,000 ounces of silver, but this was less than in 1921. Mining near Silverton was negligible until July, when the Iowa-Tiger mine and mill and the Pride of the West mine were reopened. Preparations were made in September to ship some of the stock of lead and zinc concentrates accumulated in 1920 at the Sunnyside mill, and in November a crew of men was engaged and provision made for development work at the Sunnyside mine.

Because of lack of capital, the silver deposits discovered in 1921 at the Hope and Park Tunnel mines, near Aspen, Pitkin County, could not be explored extensively, but the Smuggler mill, at Aspen, was reopened in the spring of 1922, and a silver-lead concentrate was shipped. Much "lime" ore carrying silver was also shipped to the Leadville smelter, together with certain silver ores with siliceous gangue, making an increase in silver production for Pitkin County of 50,000 ounces. In August preparations were made to unwater the Mollie Gibson shaft.

A large quantity of pyritic silver-copper ore was shipped from Gilman, Eagle County, to Salt Lake smelters.

Leadville looked for a renewal of operations in the spring and summer, but it did not come until fall, when the Louisville and other mines were reopened. The Down Town mines were operated steadily and continued to ship a variety of ores, and the Yak mines shipped pyritic silver and zinc-lead ores. The Ibex mine continued

to ship gold and silver ores, and the Fannie Rawlings and Golden Eagle mines were notable producers of gold ore containing copper in larger quantity than usual in Leadville ore. A considerable quantity of iron-manganese-silver fluxing ore was shipped from the Maid of Erin-Henriette group. Considerable silver ore was shipped from the St. Kevin-Sugar Loaf district. Work was continued on the Canterbury Hill tunnel project. Lake County, as a whole, showed increases for gold, lead, and zinc but decreases for silver and copper.

The dredges and hydraulic mines near Breckenridge produced $251,341 in gold, compared with $337,980 in 1921. The new dredge built in 1921–22 by the Yuba Construction Co. for the South Park Dredging Co. began work in May in the flood plain of South Platte River below Fairplay and continued regular production throughout the rest of the year. The morainal gravel that forms the high banks of the South Platte will be worked later by two dredges, each having twice the capacity of the present dredge and with longer bucket line for greater depth. This company controls an area 5 miles in length along South Platte River. There are other placer areas along the river, where the pioneers feverishly mined during 1860–1863 and where hydraulicking was later practiced until about 10 years ago.

The London gold mine was operated under lease and made a slightly increased production. The new South adit, 440 feet below the South London tunnel and 740 feet below the Blanchard tunnel, was continued from the south through the London fault to afford greater ease and comfort in operation and to strike a possible downward dip of the ore bodies, upon which a raise will be driven. This new adit may later be continued to cut the lower sedimentary formations in the syncline to the west.

Teller County produced $4,037,582 in gold, as compared with $4,291,883 in 1921. The Portland-Independence mill was closed July 1, after a trial on a large daily tonnage of medium-grade ore mixed with old waste material, and when it was started again in October only one unit was operated, and that on refuse from the picking belts. In August the Portland mine opened on the 2,600-foot level several ore shoots aggregating 1,000 feet, which already have been found to extend to the 2,400-foot level and which promise renewed life to the mine for some time to come. The Cresson mine has been a steady and heavy shipper of medium-grade gold ore and in the fall erected a new hoisting plant capable of sinking from the 1,700-foot level to 3,000 feet. Late in 1922 the El Paso mine was reopened. A notable strike of gold ore was made at the surface near Midway.

The intensive study of the Bonanza district made by New York men during the last three years has resulted in the financing by Bulkeley Wells, the American Smelting & Refining Co., and the members of the Rawley Mining Co. of a new company, which began in October to build a concentration-flotation mill at Bonanza. This mill will be connected by an aerial tram 7½ miles long with the Denver & Rio Grande Western Railroad's Salida-Montrose branch at Shirley. Preparations for the treatment of the concentrates from this mine have been started at the Arkansas Valley smelter, at Leadville, pursuant to the smelting company's decision to concentrate all smelting at Leadville and Durango. The Pueblo lead smelter has been sold and will be torn down.

Boulder County made a small increase in production. Clear Creek and Gilpin counties both showed appreciable increases.

*Mine production of gold, silver, copper, lead, and zinc in Colorado in 1922.*

| County. | Producing mines. | Ore sold or treated (shorttons). | Gold.[a] | | Silver.[a] | |
|---|---|---|---|---|---|---|
| | | | Fine ounces. | Value. | Fine ounces. | Value. |
| Adams | 1 | | 24.09 | $498 | 4 | $4 |
| Boulder | 60 | 3,415 | 1,791.66 | 37,037 | 121,073 | 121,073 |
| Chaffee | 8 | 6,844 | 964.40 | 19,936 | 26,187 | 26,187 |
| Clear Creek | 54 | 69,425 | 1,751.13 | 36,199 | 196,207 | 196,207 |
| Custer | 4 | 17,212 | 8.08 | 167 | 14,520 | 14,520 |
| Dolores | 5 | 678 | 94.48 | 1,953 | 30,267 | 30,267 |
| Douglas | 1 | | .58 | 12 | | |
| Eagle | 7 | 71,892 | 3,488.37 | 72,111 | 583,737 | 583,737 |
| Fremont | 1 | 7 | 1.02 | 21 | 174 | 174 |
| Gilpin | 43 | 13,707 | 2,501.96 | 51,720 | 43,910 | 43,910 |
| Gunnison | 9 | 221 | 444.08 | 9,180 | 3,803 | 3,803 |
| Hinsdale | 10 | 1,550 | 62.79 | 1,298 | 50,074 | 50,074 |
| Lake | 54 | 112,547 | 19,981.68 | 413,058 | 952,048 | 952,048 |
| La Plata | 16 | 791 | 1,560.63 | 32,261 | 10,656 | 10,656 |
| Mineral | 9 | 3,978 | 80.01 | 1,654 | 106,903 | 106,903 |
| Moffat | 2 | | 5.51 | 114 | | |
| Montrose | 2 | 251 | 15.58 | 322 | 17,968 | 17,968 |
| Ouray | 18 | 123,096 | 6,093.32 | 125,960 | 1,226,670 | 1,226,670 |
| Park | 11 | 1,120 | 6,875.07 | 142,120 | 15,528 | 15,528 |
| Pitkin | 16 | 119,023 | | | 525,169 | 525,169 |
| Routt | 1 | 1 | | | 82 | 82 |
| Saguache | 4 | 9,671 | 234.57 | 4,849 | 63,542 | 63,542 |
| San Juan | 26 | 8,808 | 1,246.09 | 25,759 | 77,864 | 77,864 |
| San Miguel | 26 | 397,840 | 52,140.80 | 1,077,846 | 1,645,459 | 1,645,459 |
| Summit | 37 | 17,894 | 13,630.22 | 281,762 | 119,604 | 119,604 |
| Teller | 55 | 432,129 | 195,318.03 | 4,037,582 | 24,462 | 24,462 |
| | 480 | 1,412,100 | 308,314.15 | 6,373,419 | 5,855,911 | 5,855,911 |
| Total, 1921 | 382 | 1,281,381 | 330,658.99 | 6,835,328 | 5,631,657 | 5,631,657 |
| Increase or decrease, 1922 | +98 | +130,719 | −22,344.84 | −461,909 | +224,254 | +224,254 |

| County. | Copper. | | Lead. | | Zinc. | | Total value. |
|---|---|---|---|---|---|---|---|
| | Pounds. | Value. | Pounds. | Value. | Pounds. | Value. | |
| Adams | | | | | | | $502 |
| Boulder | | | 68,470 | $3,766 | | | 161,876 |
| Chaffee | 20,526 | $2,771 | 661,728 | 36,395 | 178,000 | $10,146 | 95,435 |
| Clear Creek | 7,874 | 1,063 | 1,042,491 | 57,337 | 800,000 | 45,600 | 336,406 |
| Custer | 32,141 | 4,339 | 660,618 | 36,334 | | | 55,360 |
| Dolores | 24,089 | 3,252 | 87,200 | 4,796 | | | 40,268 |
| Douglas | | | | | | | 12 |
| Eagle | 1,330,296 | 179,590 | 322,818 | 17,755 | 11,000,000 | 627,000 | 1,480,193 |
| Fremont | 348 | 47 | 4,273 | 235 | | | 477 |
| Gilpin | 24,860 | 3,356 | 246,945 | 13,582 | | | 112,568 |
| Gunnison | 526 | 71 | 13,382 | 736 | | | 13,790 |
| Hinsdale | 14,269 | 1,926 | 114,200 | 6,281 | | | 59,579 |
| Lake | 871,370 | 117,635 | 5,521,818 | 303,700 | 9,003,000 | 513,171 | 2,299,612 |
| La Plata | | | | | | | 42,917 |
| Mineral | 3,422 | 462 | 153,455 | 8,440 | | | 117,459 |
| Moffat | | | | | | | 114 |
| Montrose | 61,119 | 8,251 | | | | | 26,541 |
| Ouray | 58,149 | 7,850 | 1,484,526 | 81,649 | | | 1,442,129 |
| Park | 4,215 | 569 | 155,982 | 8,579 | | | 166,796 |
| Pitkin | | | 3,555,309 | 195,542 | | | 720,711 |
| Routt | | | | | | | 82 |
| Saguache | 41,622 | 5,619 | 111,782 | 6,148 | | | 80,158 |
| San Juan | 110,348 | 14,897 | 1,651,982 | 90,859 | 1,300,000 | 74,100 | 283,479 |
| San Miguel | 673,867 | 90,972 | 7,060,891 | 388,349 | | | 3,202,626 |
| Summit | 94,413 | 12,746 | 559,330 | 30,763 | 977,000 | 55,689 | 500,564 |
| Teller | | | | | | | 4,062,044 |
| | 3,373,454 | 455,416 | 23,477,200 | 1,291,246 | 23,258,000 | 1,325,706 | 15,301,698 |
| Total, 1921 | 4,153,442 | 535,794 | 19,660,466 | 884,721 | 2,360,000 | 118,000 | 14,005,500 |
| Increase or decrease, 1922 | −779,988 | −80,378 | +3,816,734 | +406,525 | +20,898,000 | +1,207,706 | +1,296,198 |

[a] Includes placer production.

## REVIEW BY COUNTIES.[1]

### ADAMS COUNTY.

A reminder and corroboration of the existence of the intermittent gravel bars carrying sufficient gold to lead the pioneer of 1858 from Denver to Golden along the bed of Clear Creek is seen in the recovery of placer gold in 1922 by a highway contractor in a washing and sluicing apparatus attached to his gravel-screening mill on the gravel bar in Clear Creek near the point where the creek crosses the Denver-Boulder-Longmont highway that goes by way of Federal Boulevard. The bullion recovered averaged 0.858 in fineness of gold and 0.136 in fineness of silver.

### BOULDER COUNTY.

*Central district.*—The Central district, near Jamestown, produced 122 tons of ore carrying $2,803 in gold, 335 ounces of silver, and 379 pounds of lead, having a total value of $3,159, as compared with $4,644 in 1921. The production was the result of intermittent operations by lessees, who shipped small lots from seven properties. The largest shipments consisted of gold ore from the Earl-Niagara and Wano mines to the Golden Cycle mill, at Colorado Springs, part of which was shipped direct and part through the Boulder sampler.

*Gold Hill district.*—The Gold Hill district produced 311 tons of ore, which carried $8,479 in gold, 5,517 ounces of silver, and 3,733 pounds of lead, having a total value of $14,201, as compared with $12,850 in 1921. Of the 18 producing properties the principal mines were the Emancipation, Myrtle, and Scotia, from which gold ore was shipped to the Golden Cycle mill; the Goldsmith Maid and Tippecanoe, from which siliceous silver ore and lead-silver ore were shipped to the Leadville smelter direct and through the Boulder sampler; and the Nil Desperandum and Slide, from which gold ore was shipped to Leadville through the sampler.

*Grand Island district (Cardinal, Caribou, Eldora, and Nederland).*—The Grand Island district produced 313 tons of ore, carrying $1,914 in gold, 45,580 ounces of silver, and 17,431 pounds of lead, having a total value of $48,453, as compared with $46,058 in 1921. The Caribou mine, on which several sets of lessees worked continuously throughout the year and shipped high-grade silver ore in small lots, produced the bulk of the output of the district. Other producing mines were the Boulder County, Congo Chief, Grant County, Poorman, and Potosi, all shipping small lots of high-grade silver smelting ore.

*Magnolia district.*—Several small lots of ore from the Magnolia district, aggregating 28 tons, carrying $2,383 in gold and 42 ounces of silver, were purchased by the Boulder sampler.

*Sugar Loaf district.*—The Sugar Loaf continued to be the chief producing district in Boulder County, 16 mines making an output of 1,664 tons of ore, carrying $20,184 in gold, 62,192 ounces of silver, and 11,709 pounds of lead, with a total value of $83,020, as compared with $73,820 in 1921. Several sets of lessees on the Yellow Pine

[1] For production by counties see table, p. 530.

mine continued to ship small lots of silver ore of a good commercial grade, making in all a very substantial contribution to the silver production of the county. Lessees on the Logan mine shipped specimen gold to the Denver Mint and small lots of high-grade gold ore to the Boulder sampler and the Golden Cycle mill. The Red Sign mine, formerly known as a producer of tungsten ores, shipped several hundred tons of gold ore of very good grade. Lessees on the Wood Mountain mine shipped several lots of specimen gold to the Denver Mint and several small lots of smelting ore carrying a very good content of gold to the sampler. Lessees on the Ogallalah claim shipped a car of silver ore.

*Ward district.*—The Ward district produced 977 tons of ore, carrying $1,274 in gold, 7,407 ounces of silver, and 35,218 pounds of lead, with a total value of $10,618, as compared with $14,815 in 1921. The White Raven gravity-concentration and oil-flotation mill was set in operation during the year and treated a considerable quantity of low-grade silver ore at a high ratio of concentration, the product being a very good lead-silver concentrate. Small lots of gold ore were sold to the Boulder sampler from the Celestial, Humboldt, and Morning Star properties.

### CHAFFEE COUNTY.

*Chalk Creek district* (*Romley*).—Lessees on the upper levels of the Mary Murphy group shipped a considerable quantity of siliceous gold and silver ore, low in sulphur, and several hundred tons each of lead-silver-gold sulphide and oxidized ores. Several cars of silver ore, high in silica, were shipped from the Harus-Warrior mine.

*La Plata district.*—A 1-ton lot of copper-silver ore was shipped from the Banner mine, southwest of Granite.

*Middle Cottonwood Creek district* (*Buena Vista*).—The Gladstone mill, built in 1921, was operated in 1922, and a considerable quantity of ore was treated, the product being a lead-silver concentrate.

*Monarch-Garfield district.*—As a result of development work in 1921 there were four shipping mines in the Monarch-Garfield district in 1922. Several cars of zinc oxidized ore and one car of lead-silver oxidized ore were shipped from the Giant-Eclipse, several hundred tons of lead-silver oxidized ore from the Lilly, several hundred tons of lead-silver-iron oxidized ore and several cars each of silver-iron oxidized ore and zinc oxidized ore from the Madonna, and one car of lead-silver oxidized ore from the Shamrock.

### CLEAR CREEK COUNTY.

*Alice district* (*Yankee, Lincoln*).—Several small lots of gold bullion and a few tons of gold concentrate were the products of milling ore from the Champion, Clara, and Meteor properties. On August 1 the Lombard mine, long idle, was taken on lease by the Tonopah-Colorado Leasing Co., which started driving forward Lombard No. 3 and No. 4 tunnels and doing other development work in preparation for a detailed examination of the property.

*Argentine district.*—Silver sulphide ore from the Gold Belt Tunnel group, near the Loveland Pass road, was shipped to a custom concentrating mill at Idaho Springs and to the Leadville smelter, with encouraging settlement returns. A 2-ton lot of silver ore was shipped from the High Grade claim.

*Empire district.*—Lessees on the Bellevue-Hudson mine, south of the Empire railroad station, shipped a few cars of lead-silver and dry silver ores. From the Gold Dirt claim several hundred tons of gold ore was concentrated into a few cars of gold concentrate. The Silver Mountain mine and mill, under lease, produced several cars of smelting ore and concentrate, valuable chiefly for the gold content. The mill, built in 1921, is equipped with eight Davis Iron Works stamps, part weighing 150 pounds each and part weighing 300 pounds each, two amalgamating plates, and one Card table.

*Griffith district* (*Georgetown, Silver Plume*).—Eleven mines in the Georgetown-Silver Plume district produced 61,303 tons of ore, yielding $1,548 in gold, 138,815 ounces of silver, 1,111 pounds of copper, 419,200 pounds of lead, and 800,000 pounds of zinc, with a total value of $209,169, as compared with $100,157 in 1921. After the destruction by fire of the remodeled Burleigh mill on December 26, 1921, which followed a period of successful operation of the Dives-Pelican dump, the East Butte Copper Co. took this property and the adjacent Nashotah mill under bond and lease and by May, 1922, had remodeled this old mill into a flotation plant, equipped with a Blake crusher, two rolls, one Hardinge ball mill, two Chilean mills, four Akins drag classifiers, one Janney 6-cell flotation machine, and nine Akins 5-cell flotation machines. This new mill, with a capacity of 400 tons a day, treated a daily average of 250 tons of dump material from the Pelican-Diamond Tunnel properties for the rest of the year and yielded a lead-silver concentrate of very good grade at a high ratio of concentration. The Wasatch jig and table concentrating mill at Silver Plume was moved in 1921–22 to the Mendota-Frostburg mine site and was operated 179 days, producing lead-silver and zinc-silver concentrates. In addition, from this mill was sold a large quantity of zinc concentrate produced in 1920 and not hitherto credited to the district. The new mill is equipped with two crushers, two sets of rolls, three Richardson classifiers, one Wilfley and three Card tables, six 4-compartment Hartz jigs, and space for the installation of flotation machines. A 75-ton concentration and oil-flotation mill was built at the St. George mine, and a considerable quantity of ore was treated at a high ratio of concentration, producing several lots of gold-silver concentrate of good grade. A small flotation mill was built on the dump of the Sceptre-Sunburst property and in a period of several months' operation yielded several cars of good-grade silver concentrate. A 70-ton gravity-concentration and oil-flotation mill was under construction at the Silver Leaf mine. Small shipments of ore were made from the Atlas, Backbone, Capitol, Dumos, East Griffith, Gold Valley, Payrock, and Peters Tunnel properties.

*Idaho Springs district.*—The Idaho Springs district from 23 mines produced 6,497 tons of ore, carrying $27,216 in gold, 36,198

ounces of silver, 3,933 pounds of copper, and 510,982 pounds of lead, with a total value of $92,049, as compared with $86,957 in 1921. Smelting ore amounted to 565 tons; milling ore, 5,932 tons. The largest producing property was that controlled by the Gem Mining Co., which mined both milling and smelting silver-lead-gold ore from the Gem and Franklin groups. Lessees on the Edgar mine of the Big Five Co. mined a small quantity of both milling and smelting ores. Many small lots were marketed from various properties, including the Almaden, Argo (in Ute Creek), Black Eagle, Champion Trio, Chicago, Clarissa, Crocket, Dominion, Fraction, Frank J. Hayes group, Idaho-Bride, Lincoln, May Day, Seaton, and Specie Payment. The Combination, Hudson, and Newton mills were operated during part of the year.

*Montana district* (*Lawson*, *Dumont*).—The Montana district from 8 mines produced 220 tons of ore, yielding $282 in gold, 9,455 ounces of silver, 1,282 pounds of copper, and 48,146 pounds of lead, with a total value of $12,558, as compared with $36,466 in 1921. Small lots of milling and smelting ore were shipped from the Jo Reynolds, Mattie Jack, Millington, Princess, Senator, and other mines.

*Trail Creek district* (*Lamartine*, *Freeland*).—The Trail Creek district produced 193 tons of ore, yielding $1,057 in gold, 598 ounces of silver, 156 pounds of copper, and 35,854 pounds of lead, with a total value of $3,648, as compared with $3,469 in 1921. Small lots of smelting and milling ore were shipped from the Donaldson, Neglected, Teller, and Turner mines.

## CONEJOS COUNTY.[2]

Because of the inaccessibility of the ore deposits of Conejos County, nothing but assessment work has been done on them for many years. There are said to be some large bodies of low-grade gold ore in the county. The presence of arsenic in some of the ores may add to their value.

## COSTILLA COUNTY.[3]

No work of any kind was done in the mining districts of Costilla County. In the Grayback district, north of Russell, there are some gold placer areas and undeveloped low-grade gold ore bodies. In the El Plomo district, on Rio Saco, northeast of San Luis, there is said to be a large low-grade gold deposit in quartzite, suitable for quarrying.

## CUSTER COUNTY.

Smelting ores, valuable chiefly for their silver content, but also carrying lead and copper, were shipped from the Lady Franklin and

[2] For geology and description of mines at Platoro, Gilmore, and Stunner, see Patton, H. B., Geology and ore deposits of the Platoro-Summitville mining district, Colo.: Colorado Geol. Survey Bull. 13, 1917. See also Rio Grande County.

[3] For description of geology, see Patton, H. B., and others, Geology of the Grayback mining district, Costilla County, Colo.: Colorado Geol. Survey Bull. 2, 1909; also Van Diest, E. C. and P. H., Notes on the geology of the Sangre de Cristo Range: Colorado Sci. Soc. Proc., vol. 5, pp. 76–80, 1894.

Passiflora properties, near Westcliffe. One car of lead-silver ore was shipped from the Maverick mine, near Rosita. At Querida the Querida Gold Mines Co. continued the remodeling of the Bassick mill into a cyanidation plant and arranged to bring in the electric power line from Ilse, 8 miles distant. The new mill is designed to treat the old Bassick mill tailings, retained in part by a dam below the mill. Milling of the cerusite ore of the Terrible mine, at Ilse, where operations were revived in 1921, was continued throughout 1922, and a large quantity of ore was milled at a high ratio of concentration, making a concentrate carrying as much as 77 per cent of lead. This product was shipped to the Eagle Picher Lead Co.'s plant at Galena, Kans.

### DENVER COUNTY.

The old flue chambers of the Globe smelter, with additional roasting furnaces and collecting chambers, were used for the saving of arsenious oxide from flue-dust material from the Omaha, Murray, Leadville, and Selby smelters. Cadmium and thallium were also recovered. The General Chemical Co. continued to use chiefly Texas sulphur for the manufacture of sulphuric acid but was also able to use in one furnace its stock of Colorado pyrite ores purchased in 1921 and earlier years. This use was possible because the company was again able to dispose of the iron-gold-silver-lead residue to meet a demand for such fluxing material by Utah smelters. The closing of the Globe and Pueblo smelters in 1919 and 1921, respectively, had removed the near-by market for such residues.

### DOLORES COUNTY.

*Dunton district.*—Several cars of silver ore of good grade were shipped from the Emma mine, and concentration tables and flotation equipment were added to the Emma mill. Some development work was done at the Smuggler-Almont property.

*Pioneer district (Rico).*—The largest shipments from the Pioneer district were lead-silver ore from the Rico-Wellington property. The printed report of this company for the calendar year 1922 says that the ore strike that was reported a year ago did not develop according to expectations, as the ore was worked out in 40 days. No other noteworthy ore bodies were discovered during the year. The development work in 1922 amounted to 1,282 feet. Toward the end of the year the mine was leased in blocks to local miners on a royalty basis, and one of the lessees opened some smelting ore. A small lot of lead-silver ore from the Cobbler mine, a small lot of silver ore from the F. V. G. property, and a car of silver ore from the Syndicate property were shipped to the Durango smelter.

### DOUGLAS COUNTY.

A few grains of placer gold averaging 0.992¾ in fineness were recovered by sluicing the gravels of Cherry Creek, near Franktown, where small colors were obtained in 1858–59 by the pioneers on their way to the camping spot at the junction of Cherry Creek and Platte River (now part of the railroad yards at Denver).

## EAGLE COUNTY.

*Battle Mountain district* (*Red Cliff, Gilman.*)—A very large quantity of pyrite ore, carrying silver and some copper, was shipped from the Eagle mines of the Empire Zinc Co. to the Midvale, Garfield, and Murray smelters in Utah. In addition, a large quantity of zinc-iron sulphide ore from this mine was moved to Canon City, Colo., for concentration by magnetic separation and roasting to zinc oxide. Other producing mines were the Foster Combination, Ground Hog, Pursey Chester, Star of the West, and Sulphide Lease.

*Brush Creek district* (*Eagle*).—Some development work was done at an adit designed to cut at depth the extension of the inclined sandstone formation from which ore obtained close to the surface and carrying 200,000 ounces of silver was shipped in 1913–1918 from the Lady Belle-North Dakota group.

*Gypsum district.*—A little development work was done on the steeply dipping bedded pyrite deposit with gypsum gangue carrying a very small content of silver 3 miles north of Gypsum. The surface indications of this pyrite can be traced for some distance along the strike by the outcrops of hematite, limonite, and manganese oxide.

*Fulford district.*—At the head of the north fork of Brush Creek and South Eagle River, reached from Eagle and Edwards, are several interesting bedded deposits in quartzite, with some small vertical fissures cutting the bedded deposits from the schist and gneiss below. The original pyrite in these deposits is almost entirely oxidized, and some gold can be panned from the iron-stained talc and mud. Above the series of quartzites, which dip at a slightly greater angle than the surface of the ground, limestone is exposed in places near timber line, but probably because of the heavy soil and heavy timber very little if any development work has been done in the limestone formation. For many years some development work has been done in this region, but no record is available of any appreciable production, although it is said that some placer gold has been taken out below these deposits, and that some gold bullion has been recovered by amalgamation.

## EL PASO COUNTY.

At Colorado Springs the Golden Cycle 1,200-ton roast amalgamation-cyanidation mill was operated steadily but not at full capacity, chiefly on the gold ores from the Cripple Creek district and small lots of gold ore from Boulder County. The Cresson mine, in the Cripple Creek district, continued to contribute a large quantity of ore to the Golden Cycle mill, and the Portland Co., after July 1, resumed shipments of its high-grade and medium-grade ores to this mill.

## FREMONT COUNTY.

The Empire Zinc Co.'s magnetic separation plant, which had been active from 1902 to November, 1920, and its large new zinc oxide plant at Canon City, built in 1920 but not before operated, were set in operation in August, 1922, using chiefly zinc-iron sulphide ore from Eagle County and some zinc carbonate ore from Leadville. The Leadville ore went direct to the zinc oxide plant. The Ohio zinc

oxide plant, at Canon City, remained idle, but the River Smelting & Refining Co.'s matting and fuming plant, at Florence, was operated part of the year on stock ore held from 1920. A small lot of lead-copper-silver ore or concentrate was shipped from the Cotopaxi (Gumaer) mine, at Cotopaxi.

## GILPIN COUNTY.

*Southern districts (Black Hawk, Central City, Nevadaville, Russell Gulch).*—The only custom mill in operation in Gilpin County was the Polar Star amalgamation-concentration mill, at Black Hawk, and that was operated intermittently. The Midwest mill was operated on company ores only. Some Gilpin County milling ores were hauled to Idaho Springs for treatment. The operation of the mines of the southern districts showed an appreciable increase over 1921.

Within the limits of the town of Central City some smelting and milling gold ore was shipped from the Corydon mine, and one lot of copper-gold-silver ore was shipped from the Comstock mine.

In the Enterprise district, below Black Hawk, small lots of silver ore were shipped from the Champion and Mascot mines. Lessees operating through the Bryan tunnel shipped silver smelting and milling ore from the Black Jack, Coaley, and Wheeler veins.

In the area embracing Gunnell Hill and Eureka and Prosser gulches two lots of gold-silver-lead ore were shipped from the Rara Avis mine.

In the area embracing the town of Black Hawk and Gregory, Bobtail, and Bates hills there was a little more work than usual and production was made from the Dump, Klein-German, Lucky No. 2, Orion, Running Lode, and Senator mines. The Polar Star amalgamating mill was operated intermittently.

In the Hughesville-Hawkeye district, north of Black Hawk, the Midwest Co.'s new 100-ton gravity-concentration and oil-flotation mill was operated on low-grade silver ore, much of which came from the dump of the Cyclops group. Much underground development work was done in crosscutting and drifting in the Cyclops group and Midwest crosscut. Several cars of lead-silver ore were shipped from the Atlantic mine.

Mines in the area embracing Illinois and Leavenworth gulches and the eastern portion of Quartz Hill were idle.

In the Lake Gulch district two small lots of smelting gold ore were shipped from the Pittsburgh and St. Louis-Justice mines.

In the Nevada district several hundred tons of gold ore from the Ophir-Burroughs and Woods-Burroughs mines, but mined through the Argo tunnel from Idaho Springs, was milled at the Combination mill, at Idaho Springs.

In the Quartz Valley district several hundred tons of smelting and milling gold-silver ore was shipped from the Greenside, a car of smelting gold-silver ore from the San Souci, and two cars of gold ore from the Queen of the West. Small lots of ore were also shipped from the Gold Cup, the Hayseed Tunnel, and the Spur-Daisy.

In the Russell Gulch district several cars of gold-silver ore were shipped from the Druid and Frontenac mines; both milling and smelting gold ores were mined from the Fairfield-Morning Star

group; some gold ore from the Jupiter-St. Clair group was sent to an amalgamating mill; and a car each of smelting gold ore was shipped from the Two-Forty and War Dance mines.

*Northern districts.*—In the Moon Gulch district a small quantity of gold ore from the Lucky Jim property was treated by amalgamation and concentration in the 10-stamp mill.

In the Silver Creek district, near Apex, the Cornucopia Co., operating the Reform Lode group, ran its 35-ton amalgamation, gravity-concentration, and oil-flotation mill part of the year.

At Apex the Evergreen Mines Co. did assessment work only on the mines and erected two 74-foot concrete retaining walls in preparation for the installation of an electric smelting plant.

In the Perigo district one car of gold ore was shipped from the Perigo mine. On South Boulder Creek, at Rollinsville, the Perigo placer was operated for a time by a caterpillar steam shovel dumping the gravel over grizzlies, sluicing being done by a stream of water from a hose into sluice boxes. The gold recovered averaged 0.829 fine and the silver 0.119 fine.

### GRAND COUNTY.

Development work was continued in the La Plata district, on Williams Fork, in the Elk Mountain district, near Kremmling, and in the Blue Ridge district, near Parshall.

### GUNNISON COUNTY.

*Domingo district.*—No work was done in the Domingo district in 1922. The mining claims in this district, 12 miles south of Iola, show much development, and there has been in the past some production of copper ores, chiefly from the Good Hope, opened by a 700-foot shaft. There is a 400-foot shaft on the Headlight property.

*Elk Mountain district.*—A small lot of highly siliceous low-sulphur ore, carrying silver, was shipped from the Augusta mine. At the Helen Hope property, near Irwin, 181 feet of drifts were run.

*Goose Creek district (Sapinero).*—Some development work was done in the White Iron property, on Goose Creek, near Madera siding, south of Sapinero. The ore contains arsenic, gold, and silver.

*Gold Brick district (Ohio City).*—The Carter mine, opened by a 7,731-foot adit, a 1,500-foot shaft, and 5,000 feet of drifts, was operated for a short time in the fall, and shipments of several cars of gold-silver ore, high in silica and low in sulphur, were made. Lessees in the Gold Links mine shipped three cars of ore, whose chief value was in gold but which also carried some lead and silver. Contractors doing development work at the Queen mine drove 85 feet of drifts and shipped a car of lead sulphide ore, carrying gold and silver.

*Quartz Creek district (Pitkin).*—At the Roosevelt mine 500 feet of adit was driven, making the total length 2,700 feet. The continuation of this adit will cut 1,200 feet under the collar of the 400-foot shaft on the property. A test lot of gold ore was shipped.

*Tin Cup district.*—Two small lots of high-grade silver ore were shipped from the Gold Cup property.

*Tomichi district* (*Whitepine*).—Development work was continued in 1922 at the Akron mines, but shipments were not resumed until 1923.

### HINSDALE COUNTY.

The production of metals from Hinsdale County showed an appreciable increase in 1922. Several hundred tons of relatively high-grade silver ore was shipped from the Fanny Fern mine, and several cars of equally high-grade silver ore were shipped from the Belle of the West. The Lellie gravity-concentration and oil-flotation mill was set in motion, and several cars of silver-lead concentrate was produced. Other shipments, chiefly valuable for the silver content but some carrying also lead and copper, were made from the Cleveland, Cora & Sulphuret, George III, Hidden Treasure, Ocean Wave, Pelican, and Ute mines.

In the Golconda property 300 feet of drifts were opened, making a total of 6,000 feet of development. The Colorado Consolidated Mines & Power Co. continued at Sherman, 16 miles southwest of Lake City, its power development work, stringing along the surface 6,600 feet of water pipe 36 inches in diameter at the intake and tapering to 24 inches at the power house, with a fall of 427 feet. No work was done by this company on its mill or mining property, the Black Wonder group.

### JACKSON COUNTY.

The Wolverine mine, near Cowdrey, from which copper ore was shipped in 1917–18, continued idle in 1922, but shipments were made from the newly discovered fluorspar deposit 3 miles north of North Gate.

### LAKE COUNTY.

In Lake County there was a very considerable increase in gross value of metals produced, from $1,745,737 in 1921 to $2,299,612 in 1922. Gold showed an increase of more than $100,000, zinc increased in quantity from 1,821,000 to 9,003,000 pounds and in value from $91,050 to $513,171. The production of lead also increased heavily, but that of silver and copper decreased. There was very little placer gold produced, for the Derry Ranch dredge remained idle.

The total quantity of ore shipped increased from 80,501 tons to 112,547 tons. This county ranked second in the State in output of zinc, copper, and lead and third in the production of silver and gold.

#### LEADVILLE DISTRICT.

##### GENERAL FEATURES.

Of the 112,547 tons of ore mined in Lake County, 110,459 tons came from the Leadville district. The yield was $408,840 in gold, 881,451 ounces of silver, 869,511 pounds of copper, 5,484,218 pounds of lead, and 9,003,000 pounds of zinc, and the total calculated value was $2,222,478, out of a county total of $2,299,612.

*Classification of Leadville ores in 1922.*

| | Ore. | | Recovered content. | | | | |
|---|---|---|---|---|---|---|---|
| | Per cent. | Short tons. | Gold. | Silver. | Copper. | Lead. | Zinc. |
| Sulphide: | | | *Fine ounces.* | *Fine ounces.* | *Pounds.* | *Pounds.* | *Pounds.* |
| Siliceous (carrying pyrite)[a] | 9 | 10,169 | 5,968.10 | 160,473 | 411,384 | 174,716 | ..... |
| Iron pyrites[b] | 34 | 37,365 | 1,882.00 | 490,905 | 402,357 | 1,464,597 | ..... |
| Zinc-iron-lead | 10 | 10,513 | ..... | ..... | ..... | 1,043,675 | [c]5,127,000 |
| | 53 | 58,047 | 7,850.10 | 651,378 | 813,741 | 2,682,988 | 5,127,000 |
| Oxide (includes low sulphur ores): | | | | | | | |
| Siliceous gold | 4 | 3,912 | 7,121.99 | 27,320 | 37,323 | 110,454 | ..... |
| Siliceous silver | 13 | 14,415 | 234.70 | 66,935 | 13,528 | 535,990 | ..... |
| Lead (iron excess) | 3 | 3,569 | 43.10 | 16,060 | 2,975 | 880,255 | ..... |
| Lead (silica excess) | 3 | 3,372 | 1,756.90 | 26,503 | 606 | 624,533 | ..... |
| Iron-manganese flux[d] | 14 | 15,801 | 30.07 | 92,505 | 1,338 | 649,998 | ..... |
| Zinc | 10 | 11,343 | ..... | ..... | ..... | ..... | [c]3,876,000 |
| | 47 | 52,412 | 9,196.76 | 229,323 | 55,770 | 2,801,230 | 3,876,000 |
| Metallics (sulphide and oxide)[e] | ..... | ..... | 2,730.77 | 750 | ..... | ..... | ..... |
| | 100 | 110,459 | 19,777.63 | 881,451 | 869,511 | 5,484,218 | [c]9,003,000 |

| | Average recovery. | | | | |
|---|---|---|---|---|---|
| | Gold. | Silver. | Copper. | Lead. | Zinc. |
| Sulphide: | *Ounces per ton.* | *Ounces per ton.* | *Per cent.* | *Per cent.* | *Per cent.* |
| Siliceous (carrying pyrite) | 0.587 | 15.78 | 2.02 | 0.86 | ..... |
| Iron pyrites | .050 | 13.14 | .54 | 1.96 | ..... |
| Zinc-iron-lead | ..... | ..... | ..... | 4.96 | [f]30.48 |
| Oxide: | | | | | |
| Siliceous gold | 1.821 | 6.98 | .48 | 1.41 | ..... |
| Siliceous silver | .016 | 4.64 | .05 | 1.86 | ..... |
| Lead (iron excess) | .012 | 4.50 | .04 | 12.33 | ..... |
| Lead (silica excess) | .524 | 7.86 | .01 | 9.26 | ..... |
| Iron-manganese-flux[d] | .002 | 5.85 | ..... | 2.66 | ..... |
| Zinc | ..... | ..... | ..... | ..... | [f]21.36 |

[a] Much highly siliceous, and in all silica exceeds iron content. A dry gold and silver ore.
[b] Iron content exceeds silica content. A dry silver ore.
[c] Zinc in terms of recovered zinc in zinc oxide and leaded zinc oxide.
[d] Includes 176 tons of iron flux.
[e] Probably includes some Teller County and Park County specimen gold.
[f] Average assay of original content; no deduction for loss in smelting.

During 1922 the A. V. smelter of the American Smelting & Refining Co., with eight furnaces, operated two furnaces steadily and three furnaces part of the year on Colorado and Utah ores and concentrates, a small quantity of zinc residues from Kansas (formerly an important item from Kansas-Oklahoma), and transfers of ore from other plants of the company. About half of the material treated came from Lake County and nearly a third from Pitkin County (Aspen). When ore supplies slackened a considerable quantity of silver ore was drawn from the Adams mine dump and the old American smelter slag dump. The Western zinc-oxide plant, using entirely Leadville low-grade zinc carbonate ores, was operated steadily.

### MINES REVIEW.

The Down Town Mines Co., operating a large area chiefly through the Penrose shaft, kept the plant in operation continuously to insure steady pumping, but mining was done during the last 10 months only.

The Graham Park mines of the Iron Silver Co. remained under water, and the small production from other properties of this company was confined to several hundred tons of zinc carbonate ore from the Tuscon mine and a few cars of lead-silver carbonate ore from the Lime claim. Only a few cars of ore were shipped by the South Ibex Co., successor to the operation of the Garbutt and other adjoining claims, which were being opened in 1922 by a new shaft to shorten the tramming distance. Lessees continued to ship both sulphide and oxide gold ores, including a considerable quantity of high-grade ore, also some zinc carbonate ore from the Ibex mine. The Fanny Rawlings, reopened in 1921, continued to ship gold-silver sulphide ores carrying a little more copper than is usually found in Leadville ores. Lessees on the A. Y. & Minnie continued to ship iron-silver-lead sulphide and oxide ores. The Yak mines continued development work, including much diamond drilling, and shipped a large quantity of iron-silver sulphide ore and a considerable quantity of lead-zinc sulphide from the Cord, Rubie, Smuggler, and Whitecap mines and several hundred tons of highly siliceous lead-silver oxide ores from the Dolly B claim. A demand for iron from Utah smelters and from the plant at Omaha, Nebr., made a market for a large quantity of iron-manganese-silver oxide ore from the Henriette and Maid of Erin mines and for several thousand tons of iron-silver sulphide ore from the Mahala dump. The Golden Eagle mine again became an important shipper of gold-silver siliceous sulphide and oxide ores, which carry also some copper. Other producing mines were the Adelaide-Terrible, Chrysolite, Denver City, Izard, La Plata, Liddia, Lilian, Louisville, Matchless, May Queen, Quadrilateral, Robert E. Lee, and Small Hopes-Forest City.

### OTHER DISTRICTS.

*St. Kevin, Sugar Loaf, and Independence district.*—Silver ore was shipped from the Consolidated Virginius, Dinero-Inez, Fanchon, Fidelity, Prince of Wales (or Bartlett Tunnel), St. Kevin, and Snow-Arty. The Tiger-Shields was reopened for examination.

*Arkansas River dredge district.*—The Derry Ranch dredge was idle, in charge of a watchman.

### LA PLATA COUNTY.

There was a decreased production from La Plata County mines in 1922, but development work promises an increase for 1923. The principal producing mines were the Butterfly, Gold Coin, Incas, Jumbo, Kennedy, Little Nona, May Day, Mountain Lilly, Valley View, and Western Belle.

### MINERAL COUNTY.

The output of silver from Mineral County mines (all near Creede) decreased again, but much ore shipped late in 1922 was several months in reaching Durango, and returns for such ore will be credited to 1923. The principal producing mines were the Amethyst, Chama, Commodore, Corsair, Holy Moses, New York-Last Chance-Volunteer, Manitoba, Mollie S, and Monon.

### MOFFAT COUNTY.

Several small lots of placer gold averaging 0.927 to 0.952 in fineness of gold and 0.066 to 0.046 in fineness of silver were marketed from placers on Fourmile Creek.

### MONTROSE COUNTY.

Lessees on the La Sal mines, on La Sal Creek, west of Bed Rock, shipped several lots of high-grade silver specimen ore and several cars of relatively high-grade copper ore, carrying a little low silver. Sluicing of bench gravel on Dolores River, 30 miles down San Miguel River, yielded several ounces of placer gold averaging 0.797 in fineness of gold and 0.198 in fineness of silver.

### OURAY COUNTY.

*Red Mountain district.*—Five mines in the Red Mountain district produced 791 tons of ore carrying $1,676 in gold, 3,790 ounces of silver, 5,119 pounds of copper, and 23,362 pounds of lead, with a total value of $7,442, as compared with $48,444 in 1921. A small lot of high-grade copper ore assaying well in silver was shipped from the Guadalupe mine. The Barstow mine was operated all the year, and the development work resulted in the removal of several hundred tons of gold-silver ore, which was milled during the summer in the stamp and gravity-concentration mill on the property. From the Barstow openings work was continued on the Imogene group, and some ore was mined and milled.

*Sneffels district.*—Five mines in the Sneffels district produced 116,995 tons of ore, yielding $72,591 in gold, 1,208,793 ounces of silver, 46,571 pounds of copper, and 1,437,471 pounds of lead, with a total value of $1,366,732, as compared with $798,954 in 1921. The Atlas 100-ton 20-stamp gravity-concentration and oil-flotation mill was operated continuously, with a slightly increased output of lead-silver-gold-iron concentrate, and additions were made to the mill in preparation for the treatment of a larger daily mine output in 1923. The Hidden Treasure gravity and flotation concentration mill, completed and operated late in 1921, was operated for a short time in the spring of 1922 before being closed. The quantity of ore mined at the Humboldt mine was more than twice that for 1921. This silver ore continued to be milled at the Smuggler-Union mill, at Telluride, but the ore treated and content recovered are credited to Ouray County. The quantity of silver ore, with small lead content, milled from the Mountain Top mine was nearly 2½ times the quantity for 1921, with a slightly increased ratio of concentration, the lead-silver concentrate product for 1922 being more than twice that for 1921; the average content of both silver and lead was also higher. The prospecting campaign at the old Revenue mine was resumed in June, and much work was done in cleaning and retimbering. This mine is opened by a crosscut 7,700 feet long and 2,850 feet of drifts. In the course of reopening a few cars of lead-silver ore were shipped to the Leadville smelter.

*Uncompahgre district.*—Eight mines in the Uncompahgre district produced 5,310 tons of ore, yielding $51,693 in gold, 14,087 ounces of silver, 6,459 pounds of copper, and 23,693 pounds of lead, with a total value of $67,955, as compared with $22,149 in 1921. The gold came chiefly from the amalgamation and concentration of the heavy pyrite

ore from the Bright Diamond (Wanakah) mine, reopened early in 1921 by one company, which started development of the mine and remodeling of the Wanakah mill, followed more actively in December, 1921, by another company which set the mill in operation late in 1921 and continued its operation until June, 1922, when work was stopped. A few cars of relatively high-grade silver ore were shipped from the Bachelor-Khedive, Neodesha, Newsboy, Pony Express, Trout & Fisherman, and Wedge mines.

### PARK COUNTY.

*Buckskin district.*—Lessees on the Buckskin placer, equipped with one 2½-inch hydraulic giant, under a head of 182 feet, supplied by a ditch 1½ miles long, operated during June and July and recovered a small quantity of bullion, averaging 0.791 in fineness of gold and 0.200 in fineness of silver.

*Consolidated Montgomery district.*—One car of highly siliceous low-sulphur gold ore was shipped from the Magnolia mine. One car of silver ore was shipped from the Dolly Varden mine. Development work on the Russia group, started in October, 1921, was continued throughout 1922; altogether 450 feet of drifts and stopes were cut and 1,000 feet of diamond drilling was done. During this development work a car of dry silver ore was mined and shipped from the Hoosier claim.

*Fairplay district.*—The South Park Dredging Co. completed its dredge in May. It is equipped with 60 buckets of 9 cubic feet each and was operated steadily from May 21 throughout the year in the present flood plain of South Platte River between the high glacial benches at and below Fairplay.

*Hall Valley district.*—From the Missouri-La Clede group, opened by a 1,200-foot adit, several lots of very good silver ore, carrying also a fair content of gold, were shipped. Two lots of silver-lead ore from 1921 operations were shipped from the Whale mine. The Whale mine and mill were idle.

*Horseshoe district.*—During a short lease on the Hill Top mine the operator removed several hundred tons of highly siliceous lead-silver oxide ore left by previous operators. Development work at the Clover property, up Sacramento Gulch, amounted to 700 feet.

*Mosquito district.*—In the course of development work on the Champaign group a car of silver oxide ore was mined and shipped. One lot of gold ore was shipped from the Gold Wave property. Company and lessees' operation on the London mine continued to produce high-grade gold smelting ore. A leasing company on certain blocks of ground proposes to build a cyanidation mill for the treatment of the ore that is of too low grade to ship. Owing to the high altitude of this property and its distance from the railroad, only gold ore worth $80 or more to the ton can be shipped at a profit. In order to place the mine buildings and the boarding and bunk houses at a lower altitude, with the attendant improvement in living conditions and some freedom from snow and winds, and to lessen the distance of haul for fuel and supplies, the company has been driving for several years a new adit on the other side of London Mountain, about 740 feet below the Blanchard tunnel and 440 feet below the South London tunnel. It is hoped that this adit when continued will prove helpful in revealing the course of the veins in the lower

sedimentary formations, but in order to accomplish quickly the more pressing task of providing for work at a lower altitude, this adit was connected in 1922 with the known ore bodies by an inclined raise.

*Tarryall district.*—A small quantity of gold bullion was marketed from the Peabody placer.

### PITKIN COUNTY.

Pitkin County in 1922 made an increase in production of about 50,000 ounces of silver and more than 1,000,000 pounds of lead.

*Aspen district (Roaring Fork).*—The Smuggler 400-ton jig and table concentration mill, which was idle in 1921, resumed operations in May and continued throughout the year, producing from low-grade silver ore a considerable quantity of marketable silver-lead concentrate, low in silica, iron, and sulphur, the remainder including lime and barite. In addition, lessees on various properties held by this company shipped a large quantity of dry silver ore, also low in lead, iron, silica, and sulphur, and several thousand tons of higher-grade silver ore, low in sulphur but carrying more lead, iron, and silica than the dry ore. The Hunter Creek mill was operated at two different periods under different managements and treated ore from the Cowenhoven tunnel dump and from old stopes in the adit, reopened in 1921, as well as a little custom ore from other mines. During 1921–22 flotation equipment was tried at this mill in an attempt to treat the oxidized and partly oxidized ores of this district. Dry silver ore, low in sulphur, iron, silica, and lead, was shipped from the B. C. W., Millinee, and Spar. The Silver Mines Co. of America, D. R. C. Brown, the Smuggler Leasing Co., and various sublessees produced ore from the Aspen, Bushwhacker, Della S., Durant, Franklin, Late Acquisition, Mineral Farm, and Smuggler mines. The Newman Tunnel group of mines shipped a large quantity of smelting lead-silver ore, low in sulphur and iron and relatively low in silica. The Park Tunnel Mining & Milling Co., apparently both an owning and a leasing company, shipped ore from the Best Friend group, the Last Dollar-Jenny Lind group, and the Bob Ingersol. Much of the ore from this district contained lime, for which 15 cents a unit was paid. The Hope Mining, Milling & Leasing Co., which in August, 1921, struck silver ore on the contact of shale and limestone in the breast of its 6,500-foot adit, upon which work had been in progress for many years, shipped a car of relatively high-grade silver ore, carrying 72 per cent of silica and 1 per cent of iron. The Midnight Mining Co., with a large area under lease 9 miles south of Aspen, drove 1,035 feet of adit and 200 feet of drifts, making the total developments on the property, adit, 5,000 feet; drifts, 200 feet; vertical shaft, 500 feet. The Hurricane Mining & Milling Co. reports 450 feet of new development work in 1922 and the total length of its adit as 1,000 feet.

*Meredith district.*—The Aspen Silver Lead Mines Co. drove 350 feet of its 400-foot prospect adit, the portal of which is 10 miles from the nearest point on the Denver & Rio Grande Western Railroad.

### RIO GRANDE COUNTY.

*Summitville district.*—From 1873 to 1887 the Summitville district produced, chiefly from the Little Annie mine, $2,063,964 in

gold and silver, an average of $137,000 a year. In 1900 there was a total production of $112,117, and from 1873 to 1915 the total gross calculated value of gold, silver, copper, and lead was $2,554,785. Since 1915 there has been very little production and not much development work, but during 1921 and 1922 considerable development work was done on the Miser-Guadalupe group, at Jasper, 7 miles east of Summitville.[4]

### ROUTT COUNTY.

The small parcel-post test shipment made late in 1921 from the Minnie D mine, at Hahns Peak, indicated a fair content of silver but no gold. The lessee on this property worked only a few days in 1922 in trenching. Development work at the Royal Flush group consisted in diamond drilling.

### SAGUACHE COUNTY.

*Baca Grant district (Crestone).*—Prospecting on the Baca Grant and testing of dump ore on the North Star property resulted in the shipment of two cars of material, carrying a fair content in gold.

*Kerber Creek district (Bonanza).*—Several cars of good-grade silver-copper-lead smelting ore were shipped from the Cocomongo mine. During the early part of the year milling was continued at the Eagle flotation mill, from which several cars of high-grade silver concentrate were shipped. A few cars of very good silver ores were shipped from the Essie, Liberty, Mary McGinnis, and Rico mines. The Colorado Corporation was organized to take over the Rawley and adjacent properties, and in August work was commenced in tearing down the steel work of the idle Salida lead-copper smelter, to be removed to Bonanza for use in the building of a new 300-ton gravity-concentration and oil-flotation mill. This mill is to be connected by a 7½-mile tramway to the Denver & Rio Grande Western Railroad at Shirley, on the Salida-Montrose branch.

### SAN JUAN COUNTY.

The mines in San Juan County, most of which were idle throughout 1921, continued idle or were not reopened until late in the summer of 1922; consequently the county had only a small production for the year.

*Animas district.*—The Animas district, including the mines in the vicinity of Silverton and south and east of Animas River from Silverton to Middleton, yielded 6,761 tons of ore with a gross value of $130,359, as compared with $99,430 in 1921 and $457,315 in 1920. Only the Iowa-Tiger and Pride of the West operations were of importance, but 17 mines in all shipped some ore. The Iowa-Tiger mine was operated for about six months and the 100-ton gravity-concentration and oil-flotation mill for four months, with a product of lead-silver-gold concentrate. The Pride of the West mine was operated for five months. Other producing mines were the Ætna, Coming Wonder, Cranky, Dives, Fredericka, Highland Mary, King David, Philadelphia, Little Maud, Old North Star, and Queen City.

[4] For description of geology of the Summitville district, see Patton, H. B., Geology and ore deposits of the Platoro-Summitville mining district: Colorado Geol. Survey Bull. 13, pp. 65–88, 1917. See Conejos County for Platoro district.

*Eureka district.*—From the Eureka district, north of Silverton, including Chattanooga, Animas Forks, Eureka, and Red Mountain, one small lot of ore was shipped from the Early Bird mine, and lead-zinc concentrate and lead concentrate, stored from 1920 operations, were shipped from the Sunnyside mill. Comparatively little development work was done at the Sunnyside mine, and the 500-ton mill remained idle. Supplies were sent up late in 1922, in anticipation of active mining and milling early in 1923.

## SAN MIGUEL COUNTY.

The mines in San Miguel County produced less ore than in 1921, but there was an increase in metals contained in ore and concentrate shipped from the county, including the production from the Humboldt mine, which is in Ouray County but is worked from the San Miguel side.

*Iron Springs district* (*Ophir*).—Eighteen mines in the Iron Springs district produced 17,519 tons of ore, carrying $6,806 in gold, 88,192 ounces of silver, 38,007 pounds of copper, and 481,255 pounds of lead, with a total value of $126,598, as compared with $222,951 in 1921. The Valley View Mining & Leasing Co., which had a bond and lease on the San Bernardo mine, continued operation of the 100-ton gravity-concentration and oil-flotation mill, built in 1920. The product was lead-silver concentrate. Lessees on the Ida vein of the Silver Bell mine, entered through the Silver Bell adit, mined from a narrow streak and hand cobbed several cars of relatively high-grade silver ore. After a long idleness the Ophir Loop Mines & Metals Co. decided to mine the ores above the sixth level on the Butler vein of the Silver Bell mine. Of the old 50-stamp mill (1,000 pounds each) 20 stamps were supplied with ore, which after being crushed went to Brown flotation machines, a Wilfley table for pilot, and Oliver filters. The ore first mined, a sulphide in siliceous gangue, with 20 per cent gossan material consisting of red and yellow iron oxides, was not successfully amenable to flotation, so that ore was thereafter mined from the mill level of the Butler adit, 800 feet lower, where no oxidation has occurred. The product of the mill was a lead-silver-gold concentrate. The Matterhorn (Butterfly-Terrible) concentration-flotation mill was not operated, and the mine was operated only 72 days by lessees. At the Carbonero mine nearly all the year was spent in repairing a 650-foot raise, starting new levels, and repairing lower workings, but several cars of lead-silver ore were shipped. Small shipments of ore were made from the Carribeau, Crown Point, Deadwood, New Dominion, Parsons, Santa Cruz, and Shamus O'Brien.

*Klondyke district.*—Two small lots of copper-silver ore were shipped from the Klondyke district near Cedar.

*Mount Wilson district.*—A car of silver ore was shipped from the Moody mine, in the Mount Wilson district.

*Upper San Miguel district* (*Telluride*).—Five mines in the Upper San Miguel district produced 380,299 tons of ore, carrying $1,071,040 in gold, 1,557,051 ounces of silver, 634,845 pounds of copper, and 6,579,636 pounds of lead, with a total value of $3,075,675, as compared with $3,521,346 in 1921 and with $3,233,838 in 1920.

The Belmont-Wagner Mining Co.,[5] operating the Alta mines, sent twice the quantity of ore treated in 1921 to its 150-ton gravity-concentration and oil-flotation mill and produced more than twice the quantity of concentrate, which contained gold, silver, and lead. The development work at the mine amounted to 2,904 feet. In removing the machinery from the Liberty Bell mill, which had been closed in 1921 after many years of successful operation, some bullion and smelting material was marketed. The Smuggler Union mine and mills were operated 361 days. The mills of this company, which are also used to mill ore from the Humboldt mine in Ouray County, consist of the old 60-stamp amalgamation-concentration mill and a new concrete and steel 850-ton flotation plant. This new plant was completed in 1921 to replace the wooden structure destroyed by fire in June, 1920, and has floor space and head room sufficient for the installation of additional flotation cells to handle the large quantity of complex ore blocked out at the Black Bear mine, which is being held until the completion of the Coolbaugh sulphating plant at Durango, for which ground was broken in August, 1922. Lessees on some of the upper old workings of the Smuggler Union marketed gold-silver bullion. The Tomboy Co. continued to operate steadily its 600-ton gravity-concentration and selective-flotation mill (originally a cyanidation plant built in 1914; overhauled, enlarged, and changed to a concentration-flotation mill in 1919). The rough concentrate from the Wilfley tables was put through a bath of quicksilver in a small slowly revolving table mill, a reversal of the ordinary stamp-mill practice. The annual report of the Tomboy Gold Mines Co. (Ltd.) for the year ending June 30, 1922, containing the report of the manager dated September 14, 1922, says:

> During the year 243,610 tons of material were hauled from the mines to the mill. From this total 16,533 tons of waste were sorted out ahead of the crusher and put over the dump. A further 16,248 tons were deducted for moisture content, and the bin storage was low by 174 tons on June 30. The net result for the year was therefore 211,003 dry tons of ore milled, or an increase over the previous year of 13,446 dry tons.
>
> No development work of any kind was performed in the Argentine group during the year, operations still being confined to the drawing down of ore from and clearing out of the old upper level stopes, the stoping of a few remaining blocks of ore, and the breaking down of upper level floor pillars. Practically all hand tramming has been eliminated by the numerous ore passes holed through floor pillars, and the old workings are now abandoned down to the 1,500 foot level. Where several large blocks were left in place long ago because of the low grade of the ore exposed, it is planned to later drive into these blocks to determine whether or not the low grade now exposed is only local and temporary. At the present time this can not be done without mixing waste with the ore below.
>
> During the past year 83,805 wet tons were drawn from the Argentine group, or 34 per cent of the total tonnage sent to the mill.
>
> The estimated Argentine ore reserves consist of 38,083 tons of broken and 21,785 tons of unbroken ore above 1,750-foot level, 74,062 tons broken and 121,393 tons of unbroken ore below 1,750-foot level—a total of 112,145 tons broken ore and 143,178 tons of unbroken ore, or a grand total of 255,323 tons.
>
> The total Argentine ore readily available at any time totals only 59,868 tons, but this figure is taken from the estimate, which assumes certain portions of inaccessible stopes to be practically empty. This same assumption has been made several times before, and the stopes later proved to contain much more ore than was assumed. This condition can not be relied upon to continue much longer, yet it is possible and even probable that the Argentine will con-

[5] The annual report of the Tonopah Belmont Development Co. of Nevada reports investment in the Belmont-Wagner Mining Co. as $896,900.54 (Eng. and Min. Jour.-Press, Apr. 19, 1923, p. 913).

tinue to deliver its present percentage of ore for still another year, from above 1,750-foot level.

The future drawing and mining of ore from below 1,750-foot level can only be done during the periods when the workings are free from the water stored there for use in milling during the dry season of the year. Moreover, this ore is of low grade and will have to be milled with better ore from elsewhere to stand the extra cost of tramming and hoisting to the 1,750-foot level.

Development driving in the Montana mine for the year totaled only 926 feet and consisted of 572 feet of drifting, 71 feet of crosscutting, and 283 feet of raising. This does not include the dead-work drifting, crosscutting, and raising in the hanging wall of the Montana stopes to reach ore that is hung up in the stopes and blast it down for drawing.

The estimated ore reserves in the Montana mine consist of 291,962 tons broken and 123,630 tons of unbroken ore above 1,750-foot level, 26,513 tons broken and 58,399 tons unbroken ore below 1,750-foot level—a total of 318,475 tons broken and 182,029 tons unbroken ore, or a grand total of 500,504 tons.

During the year 150,038 tons of ore were drawn from the Montana, or 61.58 per cent of the tonnage sent to the mill.

The total of 84,912 tons of ore below 1,750-foot level could be taken out at any time, but not without endangering 1,750-foot level. Therefore, this ore had best remain where it is until all the upper and inside parts of the Montana are cleaned out and abandoned. Moreover, as in the case of the Argentine, this ore below 1,750 feet is of lower grade and will cost more to remove because it will have to be trammed and hoisted.

Development driving in the Virginius for the year totaled 1,956 feet and consisted of 1,361 feet of drifting, 35 feet of crosscutting, and 560 feet of raising. The long No. 26 Manway raise, driven mainly for ventilation, holed through to the surface the early part of last February, and since that time it is possible to do considerable stoping and send some of this tonnage to the mill to raise the grade of the regular mine run.

9,767 tons of ore were drawn from the Virginius during the year, or 4.02 per cent of the total tonnage to mill.

The estimated Virginius ore reserves consist of 12,689 tons of broken ore and 34,235 tons of unbroken ore, or a total of 46,924 tons.

The total ore reserves in all three mines amount to 802,751 tons, of which 443,309 tons are already broken.

Some slight progress has been made toward better extractions in the mill, and further amalgamation has been found practicable.

Mr. J. T. Terry, jr., whose ammoniacal process of selectiive flotation is in use here, after some extensive laboratory work, came here to improve our mill work but without success.

*Revenue and expenditures, Tomboy mine, June 30, 1921, to June 30, 1922.*

| | | | |
|---|---|---|---|
| 211,003 dry tons ore milled, yielding bullion worth | | | $283,178.92 |
| Concentrates worth | | | 568,187.27 |
| Cyanide plant, bullion | | | 310.30 |
| 60-mill clean-up, bullion | | | 15,905.47 |
| 60-mill clean-up, concentrates | | | 7,000.70 |
| | | | 874,582.66 |
| Sundry profit, boarding house, rents, etc | | | 14,411.88 |
| | | | 888,994.54 |
| | Per ton. | | |
| Mining and development expenses | $1.76 | $371,252.25 | |
| Milling expenses | .67 | 139,656.25 | |
| Concentrating expenses (including transportation to railway) | .71 | 150,537.44 | |
| Water-supply expenses | .17 | 35,561.73 | |
| Assay-office expense | .03 | 6,801.07 | |
| 60-mill clean-up expenses | .01 | 2,135.25 | |
| General expenses | .28 | 59,941.91 | |
| Taxes and insurance | .18 | 37,577.59 | |
| Total expense | 3.81 | | 803,463.49 |
| Profit | | | 85,531.05 |

In April, 1923, a fire occurred which completely destroyed the boiler-plant building, coal bins, and about 250 feet of snowshed and trestle between the boiler plant and the new mill building. Five days milling time were lost while rebuilding the section of trestle and reestablishing haulage communication to the mill.

On July 8, 1923, a much more serious fire occurred which resulted in the total loss of the boarding house, club building, blacksmith, machine, and carpenter shops. This fire caused a loss of only two days lost mining and milling time while preparing temporary boarding and lodging quarters.[6]

## SUMMIT COUNTY.

The rise in the price of zinc toward the end of 1922 allowed zinc concentrates stored at Breckenridge to be marketed in November and December and resulted in the reopening in December of the Wellington concentration mill at Breckenridge. Dredges and other placer operations yielded $255,298 in gold and 3,218 ounces of silver, as compared with $337,980 in gold and 4,358 ounces of silver in 1921.

*Breckenridge district.*—The value of the output of the Breckenridge district from both deep and placer mines was $350,723, as compared with $354,727 in 1921. During the spring and summer the Wellington mine was kept open, with a small force of men on constant repair work to keep the drifts to the zinc ore bodies in shape, and in addition several hundred tons of siliceous lead-silver carbonate ores were mined from surface ore bodies. Beginning in October zinc concentrates stored from 1920 operations were shipped, and in December operations were resumed at the mine and at both the gravity-concentration mill and the magnetic-separation mill on lead-zinc-iron sulphide ores. Several cars of highly siliceous low-sulphur gold-silver ore were shipped from the Alpha-Warriors Mark mine, and several cars of high-iron, low-silica, and low-sulphur silver ore were shipped from the Detroit mine. Small shipments of lead-silver or dry silver oxide ores were shipped from the June Bug, Minnie B, Monte Christo-Fredonia, and Price mines.

Three dredges, three hydraulic mines, and one sluice mine were in operation during the year. The Benrose-Bostwick placer, on the Breckenridge side of Hoosier Pass, was placed in operation late in the summer and had a small yield of gold bullion. The Mekka bench gravels were hydraulicked from June 1 to August 1 with two giants, with a fair recovery for the length of time in operation. The Washington placer was hydraulicked with one giant for 20 days. The Blue River Placer Mining Co.'s dredge of 70 buckets, of 8 cubic feet capacity each, was operated the greater part of the year. The Florence Gold Dredging Co. took over the French Gulch dredge of 80 buckets of 5 cubic feet each and operated it from August 1 to December 1. The Tonopah Placers Co. operated its No. 1 dredge (equipped with buckets of 9½ cubic feet) for 237.7 days. The annual report of this company, which is a subsidiary of the Tonopah Mining Co. of Nevada, says:

Dredge No. 1 has been operated during the season of 1922. It handled 1,393,148 cubic yards of material during the year, averaging 11.1 cents per cubic yard, giving a total production of $155,512. This dredge was closed down at the end of December for the necessary repairs to be made for the coming season.

[6] See also Eng. and Min. Jour.-Press, Dec. 16, 1922, p. 1097, and Mining Mag. (London), December, 1922, p. 384.

*Production and income statement of Tonopah Placers Co. for the year 1922.*

| | | |
|---|---|---|
| Deficit, December 31, 1921 | | $294,320.86 |
| Less deduction, for restoration of value to mineral property, plant and betterment, and dredges No. 1, 2, and 3, due to adjustment of depletion and depreciation for income tax purposes | | 360,504.48 |
| Adjusted surplus, December 31, 1921 | | 66,183.62 |
| Net earnings and income for year 1922: | | |
| Gross value of bullion shipped to mint | $155,512.19 | |
| Cost of operations | 140,888.07 | |
| Profit from operations | 14,624.12 | |
| Other income | 1,583.44 | |
| Net income for the year 1922 | | 16,207.56 |
| | | 82,391.18 |
| Reserves for year 1922: | | |
| Depletion of mineral property | 41,567.80 | |
| Depreciation of plant and betterment | 9,529.65 | |
| Depreciation of dredge No. 1 | 3,186.80 | |
| | | 54,284.25 |
| Surplus, December 31, 1922 | | 28,106.93 |
| Cubic yards dredged | | 1,393,148 |
| Gold produced, ounces | | 7,428.09 |
| Silver produced, ounces | | 1,958.19 |
| Value per yard | | $0.111 |

*Consolidated Tenmile district (Frisco, Kokomo, and Robinson).*—The Consolidated Tenmile district produced from deep mines and placer mines $24,633 in gold, 88,882 ounces of silver, 92,465 pounds of copper, and 81,821 pounds of lead, with a total value of $130,498, as compared with $82,924 in 1921.

To the Michigan group, at Kokomo, from which pyritic gold-silver ore has been shipped in considerable quantity since October 1, 1919, after an idleness from July, 1918, was added in 1921 the Uthoff Tunnel group and other claims, providing greater ease in development and mining. The Uthoff adit is 2,000 feet long. During January, 1922, the Uthoff adit was enlarged and retimbered, and a tramway was built to a sidetrack from the Colorado & Southern Railway. During the year this ore found a market at the Garfield and Murray smelters, Utah, because of the need at those smelters for iron to equalize the heavy silica content of Utah ores. The Silver Queen mine was operated from January to October, and the new development work consisted of 50 feet of shaft and 200 feet of drifts, making a total development on the property as follows: Vertical shaft, 150 feet; drifts, 900 feet; adit, 400 feet. During the period of operation several hundred tons of highly siliceous silver ore, low in sulphur, was shipped. Development work for several years resulted in the shipment in 1922 of one car each of silver ore from the Bonanza, Gray Eagle, Little Ivory, Louis, Mayflower, and Wheel of Fortune claims at Kokomo. One car of lead-silver ore was shipped by the Elk Mountain Mines Co. from the Wilfley property, at Kokomo. A car of lead-silver ore was shipped from the Four-Most group, at Frisco.

The Eureka placer, in McNulty Gulch, was operated by hydraulicking from April 26 to November 18, with one giant and 160 feet of sluice boxes, making a very creditable production of gold bullion, averaging 0.731 in fineness of gold and 0.225 in fineness of silver.

*Montezuma district.*—Ten mines in the Montezuma district produced 538 tons of ore, carrying $393 in gold, 12,625 ounces of silver, 1,726 pounds of copper, and 110,764 pounds of lead, with a total value of $19,343. The principal producing mines were the Comstock, Ida Belle, Jerry, Moonbeam, Paymaster, Pennsylvania, Rothschild, and Tempest.

## TELLER COUNTY.

Mine and dump ore, slags, slimes, concentrates, and stolen bullion from the Cripple Creek district aggregated in recovered gold to United States mints and to smelters 195,318.03 fine ounces, valued at $4,037,582, as compared with $4,291,883 in 1921, and 24,462 ounces of silver, as compared with 37,335 ounces in 1921. The Golden Cycle mill, at Colorado Springs, a roast-amalgamation-cyanidation plant of 1,200 tons daily capacity, was operated steadily at about half capacity, entirely on ores from the Cripple Creek district, with the exception of several hundred tons of gold ore from Boulder County.

In the Cripple Creek district the Portland Gold Mining Co.'s Independence 1,200-ton cyanidation and concentration mill received from January 1 to July 1 all the ore produced on company account in the Portland property and the greater part of that mined by lessees, also some custom ore. The mill was idle from July 1 to October 1, when all the ore from the Portland property went to the Golden Cycle mill. From October 1 to December 31 operations were resumed at the Independent mill, which used the rejected ore from the No. 1 and No. 2 ore houses, all picked and washed ore going direct to the Golden Cycle mill. From January 1 to July 1 the Independence mill treated 140,729 tons of an average gross content of $3.42 a ton and a total of $481,693, from which a total recovery of $359,423 was made and a profit in operation of $71,600. The cost of operating the mill plus money paid for freight and treatment was $2.05 a ton. From October 1 to December 31 a total of 32,399 tons of $3.06 gross average value was treated, at an operating expense including marketing of concentrates of $1.51 a ton, to which is added also mining and screen plant expense of $0.10 a ton, making $1.61 a ton. The profit for the three months of operation was $24,392. The gross value of ore mined and shipped to the Golden Cycle mill from the Portland mine was $576,328, and the gross value recovered by the Independence mill was $422,618, a total of $998,946.

In Poverty Gulch several thousand tons of ore was shipped from the El Paso-Gold King mine.

On Tenderfoot Hill one small shipment was made from the Queen Bess mine.

On Globe Hill lessees from the Stratton estate shipped several hundred tons of ore from the Nightingale and other claims.

On the north slope of Ironclad Hill the producing mines were the Damon group (including the Sol Cain lease on the surface discovery at Midway and company operations on the Hardwood claim), Forest

Queen, Jerry Johnson, and W. P. H. The Ironclad cyanide mill was not operated.

On Gold Hill the El Paso Extension Gold Mines Corporation shipped a few lots of ore from the Index group.

A considerable quantity of ore continued to be shipped from the Economic Mill dump, at the foot of Squaw Mountain.

On Raven and Guyot hills the producing mines were the Cresson, Doctor-Jack Pot, Elkton, and Mary McKinney. Except for the low-grade milling ore sent to the Independence mill, the Cresson mine continued to produce the largest monthly output of all the mines in the district. Shipments were made at the rate of about 10,000 tons a month, mostly from the 1,000-foot level to the 1,600-foot level. During the year a new gallows frame and boiler plant were installed, and shortly after January 1, 1923, a new hoist capable of sinking to 3,000 feet was installed. The annual report of the Cresson Consolidated Gold Mining & Milling Co. for the 12 months ending August 31, 1922 (dated October 31, 1922), says:

> During the year 121,074 tons of ore were shipped, of a gross value of $1,811,601, averaging $14.96 per ton; the returns, less transportation and treatment, were $1,174,780, giving the ore a net value of $9.70 per ton. The company received as additional income the sum of $1,101, being net royalties from 389 tons of ore shipped by lessees, and also $12,482 interest on bank deposits, making a grand total of $1,188,363, with total expenses of $596,052, resulting in a net gain from operations of $592,311. The total cost per ton of ore produced was $4.92.
>
> You will note in our company's production of 121,074 tons, with an average return of $9.81 per ton (which includes interest and royalties), our entire cost was $4.92 per ton, resulting in a net profit of $4.89 per ton.
>
> Total cash at the close of the year was $632,730.
>
> The increase of $0.97 per ton in the mining cost was due to the breaking of a large amount of ore and storing it in the stopes. Owing to the labor shortage of the past few years our reserve of broken ore was depleted, but we are now building it up.
>
> The following is a summary of operations of the company for the year ending August 31, 1922: Diamond drilling, 1,416 feet; drifts, crosscuts, raises, winzes, 4,964 feet.
>
> In addition to above, cut-outs have been made and ore chutes put in under very large areas of new stoping ground. In the past two years the bulk of the ore reserves have been developed near the bottom, the extent and value of which have made it imperative to prepare for further sinking of the shaft. The present hoisting equipment has already reached its limit in depth and capacity, and we are at present installing more suitable equipment as follows: Two boilers, headframe and hoist; the latter recommended by makers for 3,000 feet. This equipment should be ready to start around January 1, 1923.
>
> The development work for the year has been carried forward as fast as the hoisting capacity and labor supply would allow. The mine has responded, and a greater ore tonnage has been developed than shipped for that period.
>
> Stopes 617, 916, and 1015 were completed and all ore drawn. Stope 1111 remains two-thirds full of broken ore. Stopes 1203–1303 yielded tonnages beyond expectations and still contain a considerable broken tonnage. Stope 1309 remains one-third full of broken ore. Stope 1318 remains full of broken ore. Stope 1400 W. remains half full of broken ore. A new stope, 1503, is being developed over stope 1612, showing considerable area of low-grade ore. Stope 1612 crosscut opened up last year is being mined at this time, showing a fair grade of ore. Stope 1612 developed an area on the level of 300 feet by 60 feet, but 40 feet above the level values became erratic, and though it promises to go through to the fifteenth level in several places, the grade is low. Stope 1603 remains three-fourths full of broken ore. Stope 1704–1709 has now developed to 300 feet in length and roughly 60 feet in width, corresponding closely to stope 1612 above. The ore grade of this on the sixteenth level, the connecting raise, and the floor level at its bottom have all been good, making this body of ore the most important in the mine both in grade and tonnage. Distance between the sixteenth and seventeenth levels, 152 feet.

A new 1103 stope has been developed in the old 1103 system, 40 feet long and 20 feet wide, of moderate grade. Drifting in 1619 has opened up two prospects each about 35 feet long of good value. The ore shipped from all these later ore developments has sampled around $14.

There still remains above the Roosevelt tunnel level much good country for prospecting, and the new hoist equipment will enable us to sink without interfering with production.

Report of stoping and improvement operations are given you up to date of issuing this report.

*Production of the Cresson mine, 1903 to December 31, 1922.*

| Period. | Dry short tons. | Gross value. | Freight and treatment, including war tax. | Net value. | Average gross value per ton. | Average net value per ton. | Dividends. |
|---|---|---|---|---|---|---|---|
| 1903 to Aug. 31, 1921 | 855,967 | $19,365,364 | $4,986,618 | $14,379,112 | $22.62 | $16.80 | ..... |
| Sept. 1, 1921, to Aug. 31, 1922 (company ore) | 121,074 | 1,811,601 | 636,821 | 1,174,780 | 14.96 | 9.70 | ..... |
| Sept. 1, 1921, to Aug. 31, 1922 (lessees' ore) | 389 | 8,207 | 2,212 | 5,995 | 21.09 | 15.41 | ..... |
| | 977,430 | 21,185,172 | 5,625,651 | 15,559,887 | 21.67 | 15.92 | ..... |
| 1903 to Dec. 31, 1922 | ..... | 21,715,555 | ..... | ..... | ..... | ..... | $9,434,273 |

The Elkton mine, chiefly from lessees' operations, produced 20,909 dry tons of ore, with a gross value of $91,535 and a net value of $26,428, most of which was from the dump.

On Beacon Hill desultory shipments by lessees were made from the El Paso mine, and late in the year it was decided to reopen the mine on company account and to do much prospecting development work.

Producing mines on Bull Hill were the Blue Bird (Buckeye), Date, Last Dollar-Modoc, Stratton Estate (American Eagles, Orpha May dump, and others), and Wild Horse.

Producing mines between Altman and Goldfield were the Acacia (Burns), Deadwood, Findley, Golden Cycle, Isabella, Victor, and Vindicator. The Vindicator-Golden Cycle group was bought June 9, 1922, by the United Gold Mines, which gave treasury stock in payment, and it was operated by that company after that date. The Vindicator Co. produced ore up to the time of the transfer, but developments on the lower levels were disappointing. From June 9 to December 31 the United Gold Mines reports as follows:

On the Vindicator a large amount of work has been done, and on the 600-foot level we have a shoot of ore which we hope will make a profit. It is now 60 feet long and from 4 to 8 feet wide. The screenings of the first car shipped ran $63 per ton. The screenings amount to about 15 per cent of the rock broken and even at the value mentioned do not leave much profit. Development work by lessees was 2,272 feet; by company, 1,102 feet.

On Battle Mountain the producing mines were the Ajax, Bonanza, Granite, Portland-Independence group, Rose Nicol, and Strong. Lessees on the Ajax produced some ore in preparation for sampling and sale to the Tonopah Ajax Mining Co. The transfer was made August 30, 1922, whereupon the new company immediately began extensive surface and underground repairs.

The annual report of the Portland Gold Mining Co. for 1922, dated February 19, 1923, says:

The first part of the year 1922 found your company in serious financial difficulties. Decreased earnings due to added depth, low average grade of the ore, and increased cost of labor and supplies had resulted in a material de-

crease in development work and delayed installation of badly needed equipment. Further than this the mine was menaced by water, and it was evident that decisive action was necessary to prevent flooding below the tunnel level. Larger pumps were likewise essential, because of increased depth.

As soon as the necessary financial arrangements could be made an extensive development campaign was undertaken, which if it could have been carried to completion would have fully demonstrated the value of the vast tonnage of low-grade ore in the Captain area.

The main haulage way on the 700-foot level in the Independence—which corresponds to the 900-foot level in the Portland—was driven to a point well under the old Captain stopes. Due to unforeseen difficulties the final completion of this work, which includes some additional upraises and the drawing off of accumulated waste and approximately 100,000 tons of tailings which ran into this stope during the operation of the old Portland mill, was impossible because of your depleted treasury. Part of the time the chutes which were completed produced an excellent grade of milling ore, but this was soon cut off by the inrush of tailings. The possibilities of this area are known to be great, as is evidenced by steady production of screenings and middlings which are being daily drawn from the 1,800-foot level of the No. 2 shaft from a similar although much smaller area in the Hidden Treasure system. The screenings from the Hidden Treasure area were shipped at a good profit during the period in which your mill was closed down. As soon as our financial condition will permit it is the intention of the company to start drawing on the Captain chutes until the grade becomes profitable, at which time the mill can be brought to full capacity.

Late in 1921 the sinking of the 2,600-foot level was started.

Coincident with the change of management in July, it became evident that a radical change of policy was essential if your property was to continue to be operated. To this end, it was decided to shut down the mill and the Independence shaft and to curtail every unnecessary expense in operation and development. The mill was closed down on July 1 and a clean-up made. Thereafter and up to the present time all ore, except part of that produced from 1,800, has been shipped to the Golden Cycle mill at Colorado Springs. The reject from the No. 1 and No. 2 ore houses was all put into storage chutes, and it is on this character of material that the mill has run since it was started again on October 1.

We are treating from 350 to 400 tons daily, running one shift on the grinding. We are at this time negotiating for an outside dump which will materially increase our tonnage if it comes up to our expectations as to its value.

We have approximately fifty sets of lessees in the mine who are daily finding small bodies of average-grade ore, which adds materially to our production.

In July we completed the crosscut to the vein system on 2,600. This crosscut struck the vein at a point farther north than is customary, as we wished to save time in reaching the ore. The first few rounds in the vein showed increasing values until finally we found a streak equal to if not of better value than has heretofore been found in the property. Evidently we are only on the top of this rich ore shoot, for the extremely high grade has gradually pinched as we go up although it is still present 60 feet above the level. The main ore shoot in the north end has been opened to a length of 325 feet and is being stoped at this time. Perhaps the most important development of this level has been the finding of six well-defined streaks running to the northeast from the main ore body. The first of these which we encountered has been opened to a length of 125 feet and makes splendid ore for this entire distance. Recently in the northeast end of this stope a new high-grade streak has been opened. This North No. 1 East vein showed on 2,400 but was too low grade to mine. An upraise through to this level from 2,600 shows that the enriched values go up to within 25 feet of 2,400, a distance of about 130 feet vertically. The other streaks from the main ore body parallel this streak. They vary in length from 20 to 60 feet and are being carried up with the main stope. They are so close together in places that the area between them at the junction with the main vein is all mineralized to such an extent that in one place we are now breaking ore 30 feet wide. We are convinced that the main ore body continues to the north, although the values in the breast of the drift are small, and we plan further development in this direction, as we have ore on 2,400 for a distance of 150 feet beyond the breast of our present stope on 2,600.

In the south 2,600 we have already opened three chutes of a combined length of 300 feet. This ore is being stoped at this time. We have not yet reached the granite ore south, which has heretofore furnished the bulk of our best-grade ore, but we expect to reach this ore body any day. We have the 2,400 south completely drained and are pumping approximately 1,000 gallons of water per minute. The flow does not seem to vary appreciably with increased depth.

In the north end of 2,400 we recently opened a new chute 125 feet in length, which is being cut out for stoping at this time. We still have approximately 10,000 tons of broken ore on 2,400 north, which we are drawing at this time. There is still much work to be done on 2,400 north, and this area will continue to produce for many months.

On January 1, 1923, we started sinking the shaft with the intention of cutting a level at 2,735, and at this date the work is progressing rapidly. The new hoist, which is good for 3,500 feet, is working perfectly. We recently installed a 16-drill Ingersoll Rand electric compressor which is giving splendid results. From a physical standpoint the property is in better shape than it has been for some time. The 2,600-foot level, although as yet far from being completely developed, is the best level that we have had in a thousand feet.

The new level at 2,735 should be opened by the 1st of July and gives every promise of being equal to or better than 2,600.

The United Gold Mines Co., controlling properties in various parts of the Cripple Creek district, in its annual report for the year ending December 31, 1922, says:

During the past year your company has endeavored, by development and acquisition of properties thought to be desirable, to add value to your holdings.

The company itself did 1,994 feet of drifting, raising, and sinking, also 1,259 feet of diamond drilling.

The Midway and Montrose mining groups were acquired by cash payment, the Vindicator and Golden Cycle for 500,000 shares of treasury stock. A large amount of supplies and equipment were also included with the Vindicator property.

The most favorable ore development was in the Big Banta claim (near the Cresson mine), where an ore chute 50 feet long of very good grade was opened. We have a stope up 30 feet on this, and the coarse rock is shipping above $20 and screenings about $60 a ton.

Our lessees have been quite active, but no new ore of consequence has been developed by them.

The keeping in operation of the different properties of your company is important, not only in the hope of striking ore worth while but in keeping alive the mill and railroad, without which there will be no production of value from the district.

*Total production of United Gold Mines.*

| | Net tons. | Gross value. |
|---|---|---|
| Ore mined before consolidation | 26,310 | $456,806 |
| Produced under United Gold Mines Co. | 279,080 | 4,991,439 |
| | 305,390 | 5,448,245 |

*Production of the United Gold Mines Co. for the year 1922.*

| Group. | Dry tons. | Gross value. | Royalties. | Company ore. | Lessees. | Average per ton. |
|---|---|---|---|---|---|---|
| Bonanza | 507 | $27,897 | $7,643 | ..... | $15,752 | $54.98 |
| Damon | 1,463 | 26,600 | 2,398 | $5,905 | 8,347 | 18.18 |
| Deadwood | 46 | 1,222 | 176 | ..... | 640 | 26.45 |
| Trail | 1,178 | 15,284 | 429 | 7,060 | 2,200 | 12.97 |
| Vindicator | 18,388 | 226,095 | 43,138 | 29,420 | 71,926 | 12.30 |
| W. P. H | 145 | 2,268 | 212 | ..... | 1,114 | 15.63 |
| | 21,727 | 299,366 | 53,996 | 42,385 | 99,979 | 13.78 |

*Development for the year 1922.*

| | Feet. |
|---|---|
| Damon group: | |
| Sol Cain | 293 |
| Company-Hardwood | 331 |
| Deadwood group: | |
| Moore & Co | 100 |
| Requa group: | |
| Miller & Co | 92 |
| Kyner & Co | 300 |
| Company-Trail | 145 |
| Company-Big Banta | 401 |
| Vindicator group: | |
| Lessees | 2,272 |
| Company | 1,102 |
| Wild Horse group: | |
| Company | 15 |
| W. P. H. group: | |
| Cock and Chapman | 20 |
| Diamond-drill work | 1,259 |
| | 6,330 |

# COBALT.

By Frank L. Hess.

Very little cobalt was produced in the United States during 1922. A carload of heterogenite (cobalt oxide) from Good Springs, Nev., mined in 1921 from the Copper Chief claim by Harvey Hardy and R. Munzberg, the High Line by Frank Williams, the Columbia by Frank Miller, and the Blue Jay by Al Woodward, was shipped in 1922, and two other small shipments were made from the Blue Jay claim. The carload weighed 42,086 pounds net and was made up of lots carrying from 5.13 to 29.18 per cent of cobalt. The total cobalt content amounted to 4,018 pounds, valued at $1,419. The price ranged from 30 cents a pound for the cobalt in ore carrying 5.13 per cent to 44½ cents for that in ore carrying 29.18 per cent.

No output was made during the year from the Haynes Stellite Co.'s property on Blackbird Creek, south of Leesburg, Idaho, nor from the property of the Missouri Cobalt Co. at Fredericktown, Mo., from both of which some output has been made in other years.

During the summer John Bulter and John Donnelly found a little erythrite, a hydrous cobalt arsenate ($3CoO.As_2O_5+8H_2O$), known also as cobalt bloom, in a narrow vuggy quartz vein on Hot Springs Dome, near Hot Springs, on the lower Tanana River, Alaska, but the deposit does not at present seem to be important.

Although rich in many metals and minerals, the United States is poor in others—for example, in cobalt, nickel, tin, and platinum—and must import at least the larger part of its supplies. Since the discovery of the rich silver veins at and near Cobalt, Ontario, all of which carry proportionately large quantities of cobaltite (cobalt sulpharsenide, $CoS_2.CoAs_2$) and other cobalt minerals, Canada has been the principal source of the metal for the United States.

Most of the ores have been treated at Canadian smelters, but considerable quantities have been shipped to Europe. The output in 1922 amounted to 443,776 pounds, valued at $3.25 a pound, or a total of $1,442,272, against an output in 1921 of 251,986 pounds, valued at $3 a pound, or a total of $755,958.[1]

The copper ores of Katanga, Africa, as has been noted in other years, formerly carried so much cobalt that the blister copper produced from the ores for several years contained from 2 to 4 per cent cobalt. This copper has been refined in the United States for a number of years, formerly by the American Smelting & Refining Co., but lately by the Nichols Copper Co., but the cobalt content has declined to 0.10 or 0.12 per cent.

[1] Dominion Bur. Statistics, Preliminary report of the mineral production of Canada during the calendar year 1922, pp. 8, 9, 1923.

The operating company, the Union minière du Haut-Katanga, has ores in which the cobalt is predominant. No detailed description of the deposits is known to have been made public, but cobaltite, linnæite, and heterogenite have been said to occur in the deposits.

The Union minière du Haut-Katanga was formed in 1906 to exploit for the joint benefit of the Comité spécial du Katanga (practically a branch of the Belgian Government) and the Tanganyika Concessions (Ltd.), a British company, a great concession of 60,000 square miles in the southern extremity of the Belgian Congo,[2] exceeding by about 4,000 square miles the area of Illinois, Iowa, or Wisconsin. In this territory are huge rich deposits of copper and less valuable deposits of cobalt, nickel, tin, gold, silver, platinum, palladium, and uranium. The uranium deposits are the richest and the cobalt deposits are probably the largest so far discovered in the world. Similar deposits may be discovered in the adjacent part of Northern Rhodesia, where large copper deposits have already been found. At a meeting of the Tanganyika Concessions (Ltd.) in May, 1922, the chairman, Mr. Tyndale White, said:[3]

> Operations are in hand for the exploitation of the Union minière cobalt ore deposit. The reserves of cobalt are considerable. On one mine alone a figure of 22,000 tons of 7 to 8 per cent ore is given, and developments in progress should considerably add to the reserves. Recently a very rich cobalt-nickel ore deposit has been discovered at the Chinkolobwe mine, near the uranium deposit.

The report of the Union minière du Haut-Katanga of July, 1921, stated that the working of the cobalt-rich deposits had been begun and that it was intended to make a cobalt-copper alloy to be refined by the Société générale métallurgique de Hoboken (Belgium), a subsidiary company which is also to refine electrolytically the Katanga blister copper. The plant had not begun operations at the end of 1922.

Queensland appeared during the year as a notable producer of cobalt, and ore was regularly mined at Mount Cobalt, in the Cloncurry district.[4] Mount Cobalt is 19 miles south of Selwyn, the nearest railroad station, which is 71 miles southwest of Cloncurry (latitude 20° 40′ S., longitude 140° 33′ E.), by rail about 500 miles a little south of west from Townsville, on the Pacific coast. Cobalt occurs here in a vein on the contact of a diorite dike intruded into Silurian (?) schist. When the deposit was visited by Reid, in 1921, four shafts, all within a distance of 400 feet, had been sunk to depths ranging from 20 to 27 feet. The vein minerals are cobaltite (cobalt sulpharsenide) and its oxidation product erythrite (cobalt arsenate), and in one shaft there is a very thin scheelite vein. Some asbolite (cobalt-bearing powdery or friable manganese dioxide) is also found. The vein is lenticular and reaches a thickness of 3 feet. Reid estimated that there was 1,600 long tons of ore carrying between 10 and 19 per cent of cobalt within 25 feet of the surface, and between 5,600 and 6,600 tons above the 100-foot level. The ore is remarkable in that it carries neither nickel or copper, either one or both of which almost invariably accompany cobalt in its ores. Analyses by F. E. Connah show from a trace to 2 pennyweights 19 grains of gold per long ton, a trace to 18 pennyweights of silver, 10 to 19.5 per cent of

[2] Financial Times, London, July 12, 1921.
[3] Idem, May 20, 1922.
[4] Reid, J. H., Cobalt in the Cloncurry district: Queensland Govt. Min. Jour., vol. 22, pp. 12–14, Jan. 15, 1921.

cobalt, no nickel, and 9 to 28.3 per cent of arsenic. During ordinary seasons plenty of water for milling is to be had in Mort River, between 1 and 2 miles to the east, and a concentrating plant has been erected. Freight to tidewater at Townsville is £3 a ton. Most of the ore has been marketed in England, but some of it has come to the United States and Canada. The ore produced in 1921 amounted to 85 long tons, valued at £21,332, and in 1922 to 101.5 long tons, valued at £20,332.

Most of the cobalt used in the United States is imported from Canada. In 1922 the imports of cobalt ore and metal comprised 111,133 pounds, valued at $287,445, from Canada; 19,194 pounds, valued at $38,515, from England (probably of Australian origin); and 1,232 pounds, valued at $2,511, from Ireland (origin unknown)—a total of 131,559 pounds, valued at $328,471.

*Cobalt ore, cobalt, zaffer, and oxide imported for consumption in the United States, 1919–1922.*

| Year. | Ore. | | Cobalt. | | Zaffer. | | Oxide. | | Total. | |
|---|---|---|---|---|---|---|---|---|---|---|
| | Pounds. | Value. | Pounds. | Value. | Pounds. | Value. | Pounds. | Value. | Pounds. | Value. |
| 1919 | 17,045 | $2,832 | 60,511 | $141,450 | ..... | ..... | 131,424 | $184,751 | 208,980 | $329,033 |
| 1920 | 13,039 | 4,794 | 143,603 | 326,864 | 220 | $14 | 202,724 | 399,605 | 359,586 | 731,277 |
| 1921 | 7,657 | 3,235 | 38,442 | 105,539 | ..... | ..... | 164,003 | 342,426 | 210,102 | 451,200 |
| 1922 | 5,195 | 7,075 | 126,364 | 321,396 | ..... | ..... | 217,530 | 435,895 | [a]349,089 | [a]764,366 |

[a] Also 11 pounds of "other salts and compounds," valued at $26, imported Sept. 22 to Dec. 31. Not separately classified prior to new tariff.

# MOLYBDENUM.

By Frank L. Hess.

In 1922, as in 1921, no production of molybdenum ores in the United States was reported to the United States Geological Survey. The mines remained closed for lack of market, for although molybdenum was used in the manufacture of steel, the ore imported added to the stocks on hand was sufficient to supply the demand.

During the year there was undoubtedly an increase in the manufacture of molybdenum steels, but it was apparently in kinds that are not demanded in great quantity. Certain steels in which great toughness is required are improved by the addition of a small percentage of molybdenum. Shovels made of molybdenum steel show remarkable resistance to wear. The crank shafts and connecting rods of Liberty motors made during the war from nickel-chrome-molybdenum steel carried 0.3 to 0.5 per cent of molybdenum and, of course, suggest the use of similar steels for automobile and marine engine crank shafts. Spring steels carrying 0.25 to 0.40 per cent of molybdenum with fractional percentages of manganese and chromium and many other steels containing more or less molybdenum have also been made. In its uses molybdenum is a rival of vanadium and nickel, especially of nickel.

Finely developed mines and milling plants await a market that will justify their operation.

The production and importation of molybdenum ores during the last few years are shown in the following tables:

*Molybdenum in ore and concentrates produced in the United States and sold, 1917–1922.*

| Year. | Pounds. | Value. | Year. | Pounds. | Value. |
|---|---|---|---|---|---|
| 1917 | 350,200 | $495,350 | 1920 | 34,900 | $17,207 |
| 1918 | 861,637 | 1,253,700 | 1921 | ..... | ..... |
| 1919 | 297,926 | 341,814 | 1922 | ..... | ..... |

*"Molybdenum ore (steel-hardening)" imported for consumption in the United States, 1918–1922.*

| Year. | Pounds. | Value. | Year. | Pounds. | Value. |
|---|---|---|---|---|---|
| 1918 (July to December [a]) | 140,222 | $123,924 | 1921 | 29,783 | $20,471 |
| 1919 | 106,743 | 77,572 | 1922 | 412,221 | 90,015 |
| 1920 | 15,639 | 9,707 | | | |

[a] Not separately classified prior to July, 1918.

In 1922 108 long tons (121 short tons) of ferromolybdenum, valued at $267,168, was manufactured and shipped in the United States, against 19 long tons (21.3 short tons), valued at $43,866, in 1921. The ferromolybdenum made in 1922 mostly carried 55 per cent of molybdenum, though some carried 65.6 per cent. In 1921 it ran from 50 to 65 per cent, but most of it was nearer 60 per cent. During 1922 there was imported into the United States 13 long tons of molybdenum and ferromolybdenum, valued at $36,246.

# NICKEL.

By Frank L. Hess.

As usual the only nickel produced in the United States during 1922 was saved as a by-product in the electrolytic refining of copper. Since about 1890 much the greater part of the nickel supply of the United States has come from Sudbury, Ontario.

The nickel produced as a by-product of copper refining in this country since 1917 is shown in the following table:

*Nickel content of nickel salts and metallic nickel produced in the United States as a by-product in the electrolytic refining of copper, 1917–1922, and from mixed ores in 1919 and 1920.*

| Year. | Short tons. | Value. | Year. | Short tons. | Value. |
|---|---|---|---|---|---|
| 1917 | 402 | $331,556 | 1920[a] | 365 | $293,250 |
| 1918 | 441 | 401,000 | 1921 | 111 | 86,000 |
| 1919[a] | 511 | 434,485 | 1922 | 208 | 133,191 |

[a] Including nickel produced from copper-lead-cobalt-nickel ores mined in Missouri.

Considerable Canadian nickel matte is refined in this country, though now only for the making of monel metal, an alloy of nickel, copper, and some iron, formed by refining the matte without separating the nickel and copper. The alloy contains not more than 3½ per cent of iron (to add tensile strength), and the remainder is about two-thirds nickel and one-third copper. Formerly all the matte of the International Nickel Co. was refined at Bayonne, N. J., but the company now has a refinery at Port Colborne, Ontario, at the mouth of the Welland Canal on Lake Erie, where it does electrolytic refining only. All the company's nickel is refined here from matte produced at Copper Cliff. The matte carries about 82 per cent of the combined metals, nickel and copper in the ratio of about 2 to 1. The matte intended for monel metal is brought to this country. The company has recently erected at a cost between $3,000,000 and $4,000,000 a plant at Huntington, W. Va., for the manufacture of nickel and monel metal in various forms, and the matte for monel metal is refined there. The metals do not always occur in the matte in the proper ratio, and the operations are so conducted as to give an alloy with uniform composition.

In 1922 for practically the first time in many years nickel refined in Europe was seen in the United States, when the Mond Nickel Co. of England established an agency here for the sale of its metal, refined by the carbonyl process and advertised as "99.5 to 99.9 per cent pure"

and free from cobalt. The electrolytically refined nickel is, however, claimed to run 99.8 per cent of nickel (including 0.45 per cent of cobalt) with about 0.1 per cent of iron and 0.1 per cent of copper. The Mond Nickel Co. has taken over a steel plant at Hyde, 2 miles from Clearfield, Pa., that will be used for manufacturing nickel in various forms. The American branch is known as the American Nickel Corporation. The company is putting out a synthetic alloy which it at first called "Corronel" but now calls "Mond metal" and which is rather similar in composition to monel metal. Mond metal is said to contain 70 per cent of nickel, 2 to 3 per cent of manganese, about 1 per cent of impurities, and the remainder copper. The American Nickel Corporation has begun making seamless and welded nickel tubes and fittings.

Pure nickel may be worked, much as iron or steel, by rolling and welding, but it is tougher and is very difficult to punch at the necessarily high temperatures of working, so that the drawing of tubes is very difficult. Nickel tubing would be very desirable for many purposes if it could be produced at a low price.

The nickel industry was very hard hit by the treaty of Washington (1921), by which the further building of capital ships was stopped, for armor plate used on warships was the largest single use for nickel. Constant efforts are now being made to find uses for nickel that will make up for this loss of market. Among the newer uses is the making of cooking utensils from commercially pure nickel by the Nickel Fabricating Corporation, Philipsburg, Pa. The uses for nickel as estimated by the International Nickel Co. from its orders are 42.5 per cent in steel, 23.5 per cent in white metals, 17 per cent in anodes, and 17 per cent in miscellaneous uses.

Many specimens of rocks carrying more or less nickel are sent to the Geological Survey for determination, and the Survey also receives many requests for the names of buyers of nickeliferous ores. The present producers of nickel are trying to broaden a restricted market that is readily oversupplied from existing mines and smelters, so that it would seem that no new producer could come into the market without fighting for part of a trade already the subject of strong competition. To do this successfully would require large capital and ability to produce nickel at prices below the costs of the large companies now operating.

As the United States depends so wholly on Canada for its nickel it is worth while to quote the preliminary report of S. J. Cook,[1] chief of the Mining, Metallurgical, and Chemical Branch of the Dominion Bureau of Statistics:

> Of the important metals for which Canada is famous, nickel has probably suffered the severest decline. This is entirely due to the overstocked condition of the world's nickel markets and to the slowness with which the large stocks held by all the warring countries have been absorbed. Owing to its extensive use as a war metal, nickel has moved toward normal even more slowly than the other metals. The total Dominion output in 1922 was 17,496,490 pounds, or 28.5 per cent of the production during 1920, which amounted to 61,335,706 pounds. The selling price of nickel has to some extent been lowered, although quotations in New York have ranged as high as 44 cents per pound for electro-

[1] Preliminary report of the mineral production of Canada during the calendar year 1922, p. 17, 1923.

lytic, with outside markets at 32 to 34 cents. The sales during the year have been increased with a more active demand. During August the International Nickel Co. commenced shipping matte to Port Colborne, and the Mond Co., which had produced at a reduced rate, increased its production and shipped its entire stock of matte toward the end of the year. It was expected that the refinery in Wales would be running at full capacity by the end of 1922. The British America Nickel Corporation plants were inactive throughout the entire period. The total output from the Sudbury smelters amounted to 17,324 tons of matte, which contained 10,841,647 pounds of copper and 17,355,056 pounds of nickel, the average contents of metals in the matte being about 32 per cent copper and 50 per cent nickel. The year's output included, as usual, nickel metal produced as such from the smelting of silver-cobalt ores and some nickel contained in oxides and nickel salts. The nickel from these sources amounted to 141,434 pounds, all produced by the south Ontario smelters.

Of the two Canadian nickel refineries, the one at Deschenes owned by the British America Nickel Corporation was closed down, with the exception of experimental work carried on. The International Nickel Co.'s plant at Port Colborne resumed operations in September and treated 10,340 tons of matte during the last period of the year. As usual the Mond output was exported to Wales for refining. A small quantity of matte from the International Nickel Co.'s refinery at Port Colborne was shipped to the United States from which, together with accumulated residues, there was produced a small quantity of metals of the platinum group.

The exports of nickel metal, nickel-copper matte, etc., during 1921 and 1922 are shown below:

*Production in Canada and exports of nickel, 1921–1922.*

| Items. | 1921 | | 1922 | |
|---|---|---|---|---|
| | Pounds. | Value. | Pounds. | Value. |
| Production: | | | | |
| Nickel contained in matte | 19,256,900 | ..... | 17,355,056 | ..... |
| Nickel from Cobalt ores | 36,100 | ..... | 141,434 | ..... |
| | 19,293,060 | $6,752,571 | 17,496,490 | $6,123,771 |
| Exports: | | | | |
| Nickel, fine | 4,794,500 | 1,684,453 | 16,767,600 | 2,536,347 |
| Nickel contained in matte | 8,064,600 | 1,418,490 | 14,449,700 | 4,287,941 |
| | 12,859,100 | 3,102,943 | 31,217,300 | 6,824,288 |

The nickel imports and exports of the United States have been as follows:

*Nickel imported for consumption in the United States, 1918–1922.*

| Year. | Nickel, nickel ore and matte, nickel oxide, and alloys of nickel with copper, etc. | | Manufactures and nickel sheets and strips. | Total value. |
|---|---|---|---|---|
| | Pounds. | Value. | | |
| 1918 | 73,207,147 | $11,520,775 | $115,243 | $11,636,018 |
| 1919 | 36,562,388 | 8,334,135 | 90,451 | 8,424,586 |
| 1920 | 48,492,076 | 10,657,193 | 200,464 | 10,857,657 |
| 1921 | 4,396,119 | 1,210,317 | 107,155 | 1,317,472 |
| 1922 | 14,919,362 | 3,945,168 | 110,176 | 4,055,344 |

*Nickel imported for consumption in the United States, 1921 and 1922, by forms.*

| Form. | 1921 | | 1922 | |
|---|---|---|---|---|
| | Pounds. | Value. | Pounds. | Value. |
| Nickel ore (nickel content) | 660,067 | $129,053 | 3,085,632 | $396,726 |
| Nickel matte (nickel content) | 1,382,111 | 303,733 | | |
| Nickel alloys, pig, bars, etc | 2,324,993 | 770,021 | 11,341,360 | 3,438,225 |
| Nickel oxide | 28,948 | 7,510 | 492,370 | 110,217 |
| All other manufactures | (a) | 107,155 | (a) | 110,176 |
| | ..... | 1,317,472 | ..... | 4,055,344 |

a Quantity not recorded.

*Nickel, nickel oxide, and matte exported from the United States, 1917–1922.*

| Year. | Pounds. | Value. | Year. | Pounds. | Value. |
|---|---|---|---|---|---|
| 1917 | 21,992,820 | $8,936,620 | 1920 | 1,215,232 | $574,845 |
| 1918 | 17,469,500 | 6,927,041 | 1921 | 425,851 | 103,372 |
| 1919 | 3,810,656 | 1,697,544 | 1922 | 9,317,520 | 1,016,091 |

Beginning with 1922, additional classes of nickel exports are shown. The complete exports for the year are given in the following table:

*Nickel exported from the United States in 1922.*

| Class. | Pounds. | Value. |
|---|---|---|
| Oxide and matte | 9,311,680 | $1,013,069 |
| Nickel | 5,840 | 3,022 |
| Monel metal and other alloys | 913,983 | 196,702 |
| Manufactures | 249,467 | 179,094 |
| Nickel or German silver in bars, rods, or sheets | 402,922 | 121,755 |

# TANTALUM.

By Frank L. Hess.

Tantalum and its close associate, columbium, are yet among the experimental metals—those which possess attractive properties but which have not been shown to have extensive uses that some other and cheaper metal or alloy will not serve as well or better. With the numberless new uses for the elements, their alloys and compounds, that constant experimentation is developing, it seems probable that for these metals also places will be found that they will fill better than any others.

To obtain these metals in a pure state, or a state of purity comparable to that of the iron, aluminum, or copper of ordinary commerce, is very difficult and tedious, though not impracticable, as with vanadium. However, like vanadium, they can be made into ferro-alloys with comparative ease. Several patents for their use in steel have been taken out, but the steels have been made only in experimental lots. It is to be remarked that the steels made, so far as is known, have all contained both tantalum and columbium, and it is therefore not known what the effect of either metal alone would be.

The only output of ores of these metals made in the United States for several years has been that shipped by Dr. A. T. Roos, Deadwood, S. Dak. The shipments in 1922 were 600 pounds,[1] valued at $240. In 1921 Doctor Roos shipped 3,400 pounds of columbite guaranteed to contain 70 per cent of the combined tantalum and columbium oxides. The material was valued at about $1,150. The columbite came from pegmatite dikes near Keystone and Hill City, in the southern part of the Black Hills. Previous shipments by Doctor Roos have been as follows: 1920, 4,000 pounds, valued at $1,450; 1919, 300 pounds, valued at $90; 1918, 4,500 pounds, valued at $2,250. All the ore is thought to have been used for experimental purposes, most of it in ferro-tantalum-columbium, without separation of the two metals. No imports of tantalum ores were recorded in 1922.

Under the heading "Tantalum" the records of the Bureau of Foreign and Domestic Commerce show that 1,229 pounds of material, valued at $788, were included in imports for consumption in

[1] Figures are published with the express permission of Doctor Roos.

1921. From the value given it seems probable that this material was tantalum ore. The records also show that 6,785 pounds of "tantalum steel-hardening ores," valued at $1,327, were imported for consumption in 1921.

An excellent paper entitled "The story of the production and uses of ductile tantalum," by Dr. Clarence W. Balke, was recently published.[2]

[2] Chem. and Met. Eng., vol. 27, pp. 1271–1273, 1922.

# TITANIUM.

By Frank L. Hess.

During 1922 the American Rutile Co. (owned by the Thermit & Metal Corporation, 120 Broadway, New York), operated its quarry at Roseland, Nelson County, Va., and produced 310 short tons of rutile concentrates carrying about 95 per cent of titanium dioxide and as a by-product 600 tons of ilmenite concentrates carrying about 54 per cent. The ilmenite concentrates carry a little rutile so that they contain more than the theoretical quantity of $TiO_2$.

Buckman & Pritchard (Inc.), a subsidiary of the Titanium Pigment Co. (Inc.), with works at Niagara Falls, N. Y., worked the beach sands 4 miles south of Pablo Beach, Fla., in which ilmenite has been concentrated between high and low tide levels. The sand also contains considerable zircon, a little rutile, and a little monazite. During the year 4,581 tons of ilmenite carrying probably about 52 per cent of $TiO_2$ was shipped to Niagara Falls to be used for the manufacture of both ferrotitanium by the Titanium Alloys Co., an affiliated company, and titanium pigment by the Titanium Pigment Co. (Inc.).

The use of titanium pigment is apparently growing. The titanium oxide is not used alone but is precipitated with barium or calcium salts or both, so that $TiO_2$ forms only between 25 and 30 per cent of the mass. Even this is not used alone for most work, because it tends to "chalk." It is therefore mixed with zinc oxide and is thus said to form an excellent pigment. In the manufacture of the pigment it is, of course, advantageous to start with as pure an ilmenite as possible, because the iron and other impurities must be removed, and iron is the most troublesome of the impurities, because it destroys chemicals and has a high coloring power.

The operator of the pioneer pigment plant, the Titan Co. A/S, of Fredrikstad, Norway, has a deposit of ilmenite, the Laxedals, carrying about 35 per cent of $TiO_2$ and another, the Blaafjeldet, carrying between 40 and 45 per cent. Both are in Sogndal, near Raagefjord and Jössingfjord, south of Ekersund.[1] None of the larger ilmenitic deposits in the United States are so rich in $TiO_2$, unless concentrated artificially, as at Roseland, Va. Concentrates by water action are the only known deposits that approach pure ilmenite. The largest known are probably those along the coast of

[1] Jebsen, G., Den Norske titanhvitt-industri: Teknisk Ukeblad, Kristiania, vol. 67, p. 36, 1920.

Bahia, Brazil, where ilmenite concentrates of theoretical richness (52.7 per cent $TiO_2$) can be produced as a by-product of monazite mining. The high titanium content is probably in part due to a small quantity of rutile in the sand.

After September 22, 1922, when the new tariff became effective, the imports of "titanium potassium oxalate and all compounds and mixtures containing titanium" amounted to 82,544 pounds, valued at $20,596. The duty was 30 per cent ad valorem.

The market for rutile, used mostly for arc-light electrodes and for potassium-titanium oxalate to be used in dyeing and in the manufacture of leather, is small; that for ilmenite, to be used in ferrotitanium, is apparently not growing much; but the outlook for its use in the manufacture of pigments seems more promising.

# TUNGSTEN.

By Frank L. Hess.

In 1922, as in 1921, no tungsten ores were produced in the United States. The Cold Spring mine, in Boulder County, Colo., was kept pumped out by the Wolf Tongue Mining Co., as an excellent vein of ore is exposed by the workings, but in only a few other places was anything more than assessment work done.

The production of tungsten ore in the United States since 1915 has been as shown in the table below:

*Concentrated tungsten ores (carrying 60 per cent of tungsten trioxide) produced and sold in the United States, 1915–1922, and average price per unit.*

| Year. | Short tons. | Value. | Average price per unit. | Year. | Short tons. | Value. | Average price per unit. |
|---|---|---|---|---|---|---|---|
| 1915 | 2,332 | $4,100,000 | $29.30 | 1919 | 327 | $353,900 | $18.02 |
| 1916 | 5,923 | 12,074,000 | 33.98 | 1920 | 216 | 101,800 | 7.86 |
| 1917 | 6,144 | 6,783,000 | 18.40 | 1921 | None. | None. | ..... |
| 1918 | 5,061 | 7,049,300 | 23.24 | 1922 | None. | None. | ..... |

*Supplies of tungsten ores in the United States, 1916–1922, in short tons.*

| Year. | Production. | Imports. | | | Exports.[a] | | Apparent consumption plus stocks on hand (accumulated during the year only).[c] |
|---|---|---|---|---|---|---|---|
| | | Ore. | Tungsten and ferrotungsten. | Estimated equivalent in ore carrying 60 per cent of tungsten trioxide.[b] | Tungsten and ferrotungsten. | Estimated equivalent in ore carrying 60 per cent of tungsten trioxide. | |
| 916 | 5,923 | 4,072 | 43 | 4,522 | 287 | 646 | 9,799 |
| 917 | 6,144 | 4,879 | 1 | 5,310 | 1,162 | 2,615 | 8,839 |
| 918 | 5,061 | 11,609 | ..... | 12,854 | 616 | 1,386 | 16,529 |
| 919 | 327 | 9,408 | 198 | 10,915 | 19 | 43 | 11,199 |
| 920 | 216 | 1,949 | 999 | 4,416 | 2 | 5 | 4,627 |
| 921 | None. | 1,614 | 253 | 2,371 | None. | None. | 2,371 |
| 922 | None. | 1,865 | 534 | 3,300 | (d) | 1 | 3,299 |

[a] Although it is known that some has been shipped abroad, no record of tungsten ore exported is at hand until 1922, when "tungsten ore and concentrates (tungsten content)" were exported to the amount of 17 pounds, valued at $594.

[b] These items include the ore except Chinese (considered as carrying 65 per cent of tungsten trioxide) and the tungsten and ferrotungsten (considered as equivalent to 2¼ times their weight in ore carrying 60 per cent of tungsten trioxide). Chinese ore imported has been considered as carrying 67.5 per cent of tungsten trioxide.

[c] Production plus imports minus estimated equivalent in ore of the exports of tungsten and ferrotungsten. The apparent consumption is at best only an approximation.

[d] 1,009 pounds, valued at $43,219. This evidently includes tungsten wire.

Probably the most important event of the year in the tungsten industry was the passage of the tariff act, for it affected not only the American tungsten industry but that of the whole world, as the United States is the largest user of the metal. The act, which went into effect September 22, 1922, placed a duty of 45 cents a pound on the tungsten in ore (paragraph 302), equivalent to $7.14 a short-ton unit (20 pounds of $WO_3$). It also provided (paragraph 305) that there should be levied on ferrochromium tungsten, chromium tungsten, chromium-cobalt tungsten, tungsten nickel, and all other alloys of tungsten not specially provided for a duty of 60 cents a pound on the tungsten contained therein and 25 per cent ad valorem. This provision covers tungsten in high-speed and other varieties of steel, tool stellite, and other manufactures containing tungsten.

Up to the time the act went into effect there were imported 1,854 short tons of tungsten ore, valued at $279,190, which probably averaged 67.5 per cent of $WO_3$, and 520 tons of tungsten and ferrotungsten, valued at $380,732, equivalent to 1,170 short tons of 60 per cent concentrates. After the tariff went into effect only 11 tons of ore, valued at $2,061, and 14 tons of tungsten and ferrotungsten, valued at $13,995, were imported. The whole was equivalent to about 3,300 short tons of 60 per cent concentrates, or about an average year's consumption before the Great War. These imports, with the countries of origin, are shown in the following table:

*Tungsten-bearing ores imported into the United States in 1922.*

[Generalimports.]

| Country. | Short tons. | Value. |
|---|---|---|
| Bolivia | 9 | $3,031 |
| British India | 11 | 1,546 |
| Canada | 206 | 1,007 |
| Chile | 3 | 1,008 |
| China | 397 | 59,425 |
| England | 605 | 101,209 |
| France | 89 | 15,363 |
| Germany | 357 | 67,406 |
| Hongkong | 11 | 1,601 |
| Japan | 78 | 11,655 |
| Straits Settlements | 99 | 18,000 |
| | 1,865 | 281,251 |

Except those from Bolivia, British India, China, Japan, and Straits Settlements these imports were probably reshipments of ore originating in other countries than those to which they are credited, but data are not at hand to place them properly.

Except for one belated small lot the tariff act stopped the imports of tungsten. Ore to the amount of 637 tons arrived in port after the act went into effect, but this ore was reshipped to Europe to avoid the duty. As the duty was high enough to keep out foreign ores, it of course raised the price of some thousands of tons of stored ore, but it did not reopen any mines in this country. The cream had been skimmed from most of them during the period of high prices in the World War, and in nearly all tungsten mines all ore in sight that was minable at prices ranging from $12 to $28 a unit had been taken out. There are notable exceptions, and the excep-

tional mines will again be worked when the present large stocks of tungsten ore are exhausted.

A second remarkable feature of the year was the continuation of a large production in China in spite of the very low prices, probably averaging less than $3 a short-ton unit for ore landed at New York or London. The ore as shipped in 1922 is said to be nearly all of high grade, containing probably 68 per cent of $WO_3$. It contains some tin. The following analyses show the composition of actual shipments of wolframite from southeastern China:

*Analyses of wolframite ores from southeastern China.*

| | 1 | 2 | 3 | 4 |
|---|---|---|---|---|
| Tungsten trioxide ($WO_3$) | 68.63 | 68.83 | 71.05 | 72.04 |
| Sulphur (S) | .08 | .03 | .15 | .22 |
| Tin (Sn) | Trace. | .21 | .83 | 1.24 |
| Copper (Cu) | .02 | .02 | .02 | .02 |
| Phosphorus (P) | .006 | .013 | .002 | .003 |
| Manganese (Mn) | 3.51 | 6.30 | 9.52 | 9.52 |
| Moisture ($H_2O$) | | | | .08 |

Analyses 1 and 2 by Ledoux & Co., New York; 3 and 4 by Pittsburgh Testing Laboratories, Pittsburgh; 1, 17,864 pounds (after drying); 2, 55,005 pounds (after drying); 3, 99,136 pounds (after drying); 4, 100,278 pounds.

The extent and future prospects of Chinese cheaply mined tungsten ores are probably not known even to the principal producers and are much in need of investigation. Most of the ore is shipped more than 100 miles from southwestern Kiangsi or northern Kwangtung by human transport and small river boats to the ocean at Canton or Hongkong. Great Britain and Germany took largely of the Chinese ore, practically all of it after the passage of the United States tariff act. The wolframite exported during the year is reported [1] as 56,951 piculs (1 picul equals 133⅓ pounds), equivalent to about 4,275 short tons of ore carrying 60 per cent of $WO_3$.

Burma was the only other considerable producer and made an output of 700 long tons of wolframite ore and 312 long tons of mixed ore.[2] The exact content of $WO_3$ is unknown, but the cleaned concentrates are said to carry 70 per cent of $WO_3$ and the mixed concentrates are thought to carry about 50 per cent. On these bases the output would be equivalent to about 1,206 short tons of ore carrying 60 per cent of $WO_3$.

Official reports show that the Federated Malay States produced an equivalent of about 120 short tons of wolframite (including less than 1 ton of scheelite); Bolivia, 9 tons; England, 3 tons; Queensland, 5 tons; Tasmania, 23 tons; Southern Rhodesia, 50 tons; Indo-China, 112 tons. Portugal is the only considerable producer from which no reports are obtainable.

These countries account for 5,803 short tons of ore carrying 60 per cent of $WO_3$. The total world's production was probably equivalent to little if any more than 6,000 short tons (5,445 metric tons) of ore carrying 60 per cent of $WO_3$.

[1] Maritime Customs, Foreign trade of China, 1922, pt. 1, Report and abstract of statistics, p. 23, Shanghai.

[2] Moffitt, J. P. (American consul, Rangoon), letter Sept. 4, 1923.

Few data are at hand showing the consumption of tungsten ore in 1922, but it was probably less than 5,000 tons of ore, including its equivalent in tungsten and ferrotungsten, and there was probably on hand at the end of the year a stock of tungsten ore, tungsten, and ferrotungsten equivalent to between 10,000 and 12,000 short tons of ore carrying 60 per cent of $WO_3$.

The year began with Chinese ore carrying 67½ per cent of $WO_3$, or more, at $2 a unit in New York, and Bolivian ore of higher grade at $2.50 to $3 a unit. In March, even with the assurance of a heavy duty, the price of Chinese ore dropped to $1.80 for material that was a little off color but usable. Soon after the tariff bill became a law heavy buying began, showing that many steel makers had not covered their needs, and the price advanced to $7 for Chinese ore. By November scheelite of good quality sold for $8 a unit, and these prices remained to the end of the year. Prices abroad were less than $3 a unit to the end of the year.

# RADIUM, URANIUM, AND VANADIUM.

By Frank L. Hess.

## RADIUM AND URANIUM.

In 1921 the producers of radium carried stocks so large—a few thimblefuls apiece—that they sold much of their product for prices that did not allow a proper profit, and they started the year 1922 with probably between $1,000,000 and $2,000,000 tied up in radium and with considerable ore on hand. Worse than these conditions was the fact that they faced the competition of the extremely rich and cheaply produced ore from Katanga, in the south end of the Belgian Congo, so that their outlook for the year was very poor.

Four companies produced radium in 1922, and four mines were operated. The radium produced during the year amounted to 24.189 grams of radium in salts and was isolated by the Standard Chemical Co., of Pittsburgh, Pa.; the United States Radium Corporation, of New York City; the Radium Corporation of Colorado, of Denver, Colo.; and the Keystone Metals Reduction Co., of Pittsburgh. The production was only about two-thirds of the 35.693 grams isolated in 1921. In 1920 the quantity was 32.539 grams, and in 1919 it was 28.648 grams.

Only 929 tons of dry ore was mined and shipped during the year. It contained 27.35 tons of $U_3O_8$ (23.2 tons of uranium), 7.015 grams of radium, and 46.27 tons of $V_2O_5$ (25.9 tons of vanadium) and was valued at $166,016.

Carnotite was produced from only four groups of claims during the year. The United States Radium Corporation mined through the year from its claims in Long Park, Colo., on the north side of Paradox Valley, between the valley and San Miguel River. The park is in Montrose County, about 60 miles northwest of the Rio Grande Southern Railroad at Placerville. The ore was shipped to the plant of the corporation at Orange, N. J.

The Keystone Metals Reduction Co. operated a mine on Polar Mesa, on the north side of the La Sal Mountains, Utah. The property is about 40 miles, including 15 miles by trail, from the Denver & Rio Grande Western Railroad at Cisco, Utah. The company mined ore of excellent grade, carrying 3.5 to 5.5 per cent of $U_3O_8$ and 4.5 to 5 per cent of $V_2O_5$. The ore was shipped to its plant at Keswick, Pa.

Other ores were mined on the east side of the La Sal Mountains and south of them on Cane Springs Wash.

No vanadium ores distinct from uranium ores were mined in the United States during the year.

A discovery of vanadium ore of the same type as that furnishing most of the vanadium in the carnotite region was made known early in the year by J. W. Brown and associates, of Rifle, Colo., and later the claim was taken over by H. K. Thurber, George Kunkle, and others, of Grand Junction, Colo., who formed the Vanadium Corporation of Colorado. The deposit is described as lying in sandstone on Rifle Creek, 11 miles from the Rifle railroad station. The outcrop is said to be 2,500 feet long and as much as 7 feet thick. The ores carry small quantities of carnotite but are not rich enough to work for radium alone. This is the most conveniently located deposit of vanadium ore now known.

The Katanga radium ores continue to dominate and almost absorb the market for radium. The standard price of $70 a milligram has been maintained through the year. In this country the Belgian radium has been sold by the Standard Chemical Co. and the Radium Co. of Colorado, on account of their excellent selling organizations. Not very much information has been published concerning the extent of the deposits, but some items of interest were given at a "manifestation coloniale" held at Tervueren, Belgium, in November.[1] The first discovery was made January 22, 1913, during prospecting work in the Luiswishi copper mine, but owing to the war and other causes little was done about the discovery. On April 10, 1915, a second discovery was made in the course of delimiting the copper deposit at Chinkolobwe (Kasolo), and the ores have so far come from this deposit. The veins are in greatly crumpled and faulted metamorphic rocks, including talcose schist, dolomite, and breccia. The veins branch and pinch to mere cracks, so that little can be told of the quantity of ore to be obtained. Mining is done by open cuts, and development and extraction are simultaneous. In the thickest parts of the veins the center is pitchblende and the outer part consists of alteration minerals, principally torbernite. Curite and kasolite are the other most common minerals. Many of the vein outcrops carry cobalt and copper.

The investigation of the minerals of the deposits has been turned over to Prof. A. Schoep, of the University of Ghent, Belgium,[2] who has described six new uranium minerals from these deposits as follows:

Becquerelite, hydrous uranium trioxide. The mineral is brownish yellow with a resinous luster. Rhombic with two cleavages. An analysis of becquerelite gave 86.51 per cent $UO_3$, 5.82 per cent $H_2O$, and 5.25 per cent PbO. Schoep derives the formula $UO_3 2H_2O$.

Curite, hydrous lead uranate. In tiny bright yellow or orange acicular crystals, reddish brown by reflected light. Also in sugary orange granules and earthy masses. The analyses showed 74.08 to 74.37 per cent $UO_3$, 21.08 to 21.57 per cent PbO, and 4 per cent $H_2O$. The formula derived is $2PbO.5UO_3.4H_2O$.

Dewindtite. In minute translucent rectangular crystals. Contains about 55.50 per cent $UO_3$, 21.74 per cent PbO, 10.01 per cent $P_2O_5$, and 5.82 per cent $H_2O$. The formula derived is $4PbO.8UO_3.3P_2O_5.12H_2O$. Specific gravity, 4.8.

Kasolite, a monoclinic hydrous lead uranium silicate. Ocher-yellow or brown-yellow, sugary, powdery, and in tufts or stars of columnar crystals.

[1] Communications faites en présence de S. M. le Roi, à la manifestation coloniale de Tervueren, le 13 novembre 1922 (a collection of several papers).

[2] Sengier, E., La découverte du minerai de radium au Katanga: Op. cit., pp. 23–29.

Analyses gave $UO_3$, 49.28 per cent; PbO, 36.20 per cent; $SiO_2$, 9.42 per cent; and $H_2O$, 3.59 per cent. Derived formula, $3PbO.3UO_3.3SiO_2.4H_2O$.

Soddite, a rhombic hydrous uranium silicate. In small yellow crystals. An analysis gave $UO_3$, 85.33 per cent; $SiO_2$, 7.83 per cent; and $H_2O$, 6.23 per cent. Derived formula, $12UO_3.5SiO_2.14H_2O$.

Stasite. Has the same chemical composition as dewindtite but differs in crystal form and specific gravity (5.03). Formula, $4PbO.8UO_3.3P_2O_5.12H_2O$.

Since these minerals were described T. L. Walker [3] has described from its crystal form a seventh new uranium mineral of the Katanga deposits, which he has named schoepite (pronounced scoop'ite). No analysis has been made. Like the others, it is an alteration product of pitchblende.

P. J. Leemans [4] states that the first lot of 12 tons of uranium ore was received at Anvers, Belgium, December 5, 1921. Construction of an elaborate factory for isolating radium was begun at Oolen, near Hoboken, Belgium, early in March, 1922, and part of it was put into commission July 8. The process of reduction is given in a general way and is very simple, because the ore is very simple. In December 2.7 grams of radium was turned out. The works, operated by the Société générale métallurgique de Hoboken, subsidiary to the Union minière du Haut-Katanga, is said to have a capacity of 3 grams of radium a month in a salt carrying 95 to 96 per cent of RaCl. An estimate of 450 tons of ore, half of which has been shipped, carrying about 121 milligrams of radium to the ton and containing a total of, say, 54 grams of radium has been made. This is probably low, however, for the ores are found on other claims. The report of the Société belge industrielle et minière du Katanga [5] states that "'certain indications had induced the company's prospectors to take a series of claims for uranium in the Panda region.' The research and surveys in this connection formed part of the new program which was being elaborated by the company."

The copper deposits of B'wana Makuba, in Northern Rhodesia, are said to be a continuation of the Katanga deposits, and it is possible that other uranium ores may be found there.

Very little information has been at hand concerning the Siberian deposits that for years have been known to exist in Tyuya Muyun Hill, in the province of Ferghana, Russian Turkestan, where the first lime-bearing carnotite was obtained and from which came the name tyuyamunite. A recent article by S. P. Alexandrov,[6] a Russian engineer, furnishes so much information and is so inaccessible to most readers that a translation of it by Miss L. M. Jones, of the United States Geological Survey, is given here.

The famous Russian radium deposit of Ferghana was investigated in the summer of 1922 by a special expedition sent out by the State Radium Institute of the Russian Academy of Science jointly with the Central Council of Industrial Research.

The Tyuya-Muyun deposit is situated in the southeastern part of Ferghana, in the first foothills of the Alai Mountains, approximately 60 kilometers east of Skobelev and 30 kilometers southeast of Osha.[7]

The deposit presents certain peculiarities in that the ore appears principally as stalactitic forms on the walls of caves and crevices which occur in Paleozoic limestones and apparently were formed by tectonic processes.

[3] Walker, T. L., Schoepite, a new uranium mineral from Kasolo, Belgian Congo: Am. Mineralogist, vol. 8, pp. 67–69, 1923.

[4] Communications * * * à la manifestation coloniale, pp. 13–21.

[5] Min. Jour. (London), vol. 139, p. 867, Nov. 18, 1922.

[6] Gornyi Zhurnal, vol. 118, pp. 415–416, Moscow, 1922.

[7] The geographic position of Tyuya-Muyun is 40° 21′ north latitude, 72° 35′ east longitude from Greenwich.

In its composition the ore is very complex. The useful minerals that are found in the ore are tyuyamunite (uranovanadate of calcium), volborthite (calcium-copper vanadate), turanite (vanadate of copper), malachite, radioactive barite, etc. Calcite forms a barren layer.

The deposit has been known for a long time by the Chinese, who worked it in a primitive way for copper, and only in 1904 was more or less systematic work begun on investigating the character and reserves of the deposit.

The information obtained from this work, which was done by the "Ferghana Company for the Production of Rare Metals," was not published and much concerning Tyuya-Muyun remains unknown.

The company's entire output from Tyuya-Muyun to the cessation of operations in 1914 was about 1,000 tons of ore, of which 700 tons was worked for copper, uranium, and vanadium; the remainder of the ore and the residues from chemical treatment, containing 2.3 grams of metallic radium, served as raw material for the Government's radium plant at Kame, erected under the supervision of the Russian Academy of Science. * * *

The underground workings of the mine, examined by the expedition, are in two horizons. The upper horizon shows an intricate system of connected natural caves, the passages between which were clearly made with the help of explosives by our predecessors. The upper horizon is at a depth of about 14 meters [46 feet] from the collar of the shaft and has four outlets to the surface. The lower horizon shows a group of caves of small size strung together like a rosary, the connection between them being also clearly made with the help of explosives. The caves of the lower horizon begin at a depth of 26 meters [85 feet] and extend, sinking spirally, to 59 meters [192 feet] below the collar of the shaft. The work caves of the lower horizon extend through a length of about 48 meters [156 feet].

The shaft, starting from the surface of Tyuya-Muyun Hill, passes through a large cave extending in a vertical direction, below which the horizon extends 35 meters, where it terminates in a barren zone.

The ore produced by the Ferghana Co. up to the cessation of its operations came from these explored workings. Excavation of the cavity is incomplete. The ore in sight, exposed in the existing workings, is estimated by the expedition at 5,000 tons, of which about 1,600 tons is found in the upper horizon, about 800 tons in the large cave crossing the shaft, and about 2,600 tons in the lower horizon.

With a content of 1 gram of radium metal to 250–350 tons of crude ore [this would indicate ore carrying 1.14 to 1.5 per cent of $U_3O_8$—F. L. H.], the ore in sight should contain, according to an estimate rendered uncertain by the waste contained:

| | | |
|---|---|---|
| Radium metal, total | grams | 15 to 20 |
| Uranium metal, total | tons | 60 |
| [60 tons of uranium would carry about 18.26 grams of radium—F. L. H.] | | |
| Vanadium metal, total | tons | 90 |
| Copper metal, total | do | 120 |

In order to obtain exact data on the content of metal, various samples were collected by the expedition.

More ore is present than that indicated as "in sight," and the expedition also discovered a new vein, the Academic, of commercial interest, 180 meters [585 feet] west of the Glavno (=Chief) vein exposed by the workings of the mine.

Finding conditions entirely satisfactory as regards the organization of mining operations, the expedition hand-cobbed and sent to the plant 30 tons of the best ore, having repaired the wagon road to the Fedchenko station of the Central Asiatic Railroad, which is about 60 kilometers [37½ miles] distant from the deposit. * * *

On the basis of the material gathered by the expedition from the Tyuya-Muyun deposit, it is proposed to operate the mine in 1923 with an initial production of 500 tons of picked ore a year, having in view an increase of this output in proportion to the increase of the known reserves of the deposit resulting from new exploration to be conducted coincidentally with the exploitation.

Detailed general and special reports by members of the expedition will soon be published.

In 1922 Madagascar produced and shipped to France 15.87 metric tons (17.5 short tons) of betafite, a complex titanium, columbium, tantalum, and uranium mineral obtained from decomposed beryl-bearing pegmatites. The ore is said to carry 1 gram of radium to each 12 to 20 metric tons, so that the ore produced probably contained about a gram.

In Cornwall 393 long tons (440 short tons) of uranium ore, presumably carrying both pitchblende and the alteration minerals autunite and torbernite,[8] was produced in 1922. The ore had a content of 2 per cent $U_3O_8$, so that it carried a little more than 2 grams of radium.

Czechoslovakia (formerly Bohemia) produced from the ancient mines at Joachimsthal (now known as Jachymov) pitchblende from which 2.2 grams of radium was produced,[9] against 3.2 grams in 1921. Between 1853 and 1913 the mines produced 1,659 short tons of pitchblende ores of unknown uranium content. The mines also produced 6,112 tons of silver between 1517 and 1900, 20 tons of cobalt between 1775 and 1851, and other quantities of bismuth, lead, and arsenic. In 1922 the Czechoslovakian Government bought the old Sylva-Tarouca mines, in the southern part of the town of Joachimsthal, and expects by again operating them to increase greatly the output of pitchblende. The total production of radium in Czechoslovakia from 1909 to 1922, inclusive, amounted to 24.7 grams.

Since radioactivity was discovered in spring waters much has been made of the fact in advertising such waters as curative agents. Whatever the virtues of the water may be at the springs, Skinner and Sale [10] show by careful tests that shippers of water in this country are not justified in advertising the bottled waters for their radioactivity, as it is lost within a few days.

A suit was brought to test the validity of a patent (Junghaus, No. 911401) "covering certain new and useful improvements relating to an improved luminous substance for indicators containing radium for the indicating members of clocks, speed gages, and the like." It was shown in court (279 Federal, 1016) that in 1903, before the Junghaus patent was taken out, Dr. George F. Kunz applied a radium paint to his watch and Major Hammer put radium paint on his clock; also that there was a long list of prior art patents and scientific publications on the subject, so that the patent was held invalid. The German and Swiss courts also decided against the patent.[11]

## VANADIUM.

The United States made no production of vanadium ores as such during 1922.

Although for several years vanadium has been produced in this country only as a by-product of radium production, it seems sure that vanadium will again be obtained from the vanadium-uranium bearing sandstones of the plateau region. The deposits are found

[8] Secretary for Mines (Great Britain) Second Ann. Rept. for 1922, pp. 91, 105, 1923.
[9] Letter from Dr. Stan. Spacek, technical attaché, Czechoslovak legation, Washington.
[10] Skinner, W. W., and Sale, J. W., Radioactivity of miscellaneous waters examined in the Bureau of Chemistry: Jour. Ind. and Eng. Chemistry, vol. 14, pp. 949–950, 1922.
[11] Gustin, Wellington, Junghaus patent for luminous compound invalid: Chem. and Met. Eng., vol. 27, p. 1258, 1922.

from a point about 15 miles northeast of Meeker, Routt County, Colo., to Navajo Mountain, on the line between New Mexico and Utah, in a belt more than 200 miles long and more than 50 miles wide. Most of the country is a long way from a railroad, the deposits are generally of low grade and are sporadic, and the country is rough, semiarid, and sparsely populated, but there are some deposits of rather wide extent with thousands of tons of sandstone carrying 2 per cent or more of $V_2O_5$. The material can be concentrated to two or three times this richness by removing the sand. Although no process has yet been applied that is capable of profitably isolating vanadium from ores of such low grade it seems within the realm of probability that a process may sometime be devised. Concentration plants might be established at several selected points, the concentrates could be shipped, and possibly radium could be made as a by-product.

Another possible source of future production has been brought out by the work of George R. Mansfield, of the United States Geological Survey, on the western phosphate deposits. He has drawn attention to the fact that the better-grade phosphate rock of Idaho usually carries vanadium in quantities ranging from 0.11 to 0.52 per cent $V_2O_5$.[12]

Analyses to determine the vanadium content of the phosphate rock at Paris, Idaho, formerly used by the Anaconda Mining Co. showed 0.23 and 0.28 per cent of $V_2O_5$. The rock the company is using, from Conda, Caribou County, Idaho, is thought to have about the same vanadium content. The tailings from the chemical concentrates are said to be free from vanadium, and unless there was a loss at some other point in the operation, this would indicate a complete saving of the vanadium. The concentrated phosphate solution showed 0.32 per cent of $V_2O_5$, almost 1½ times the lower content shown in the phosphate rock, corresponding very well, if this is used as a basis, with the concentration of the phosphorus contained in the original rock. If 1,000 tons of phosphate rock a day, or say, 360,000 tons a year, should be handled, as is said to be the company's intention, that would mean, if the ratio stated should hold, a daily content of about 2.1 tons of $V_2O_5$, and a yearly content of 756 tons of $V_2O_5$, or 423 tons of vanadium. This is a larger quantity than the average production of vanadium in ores of the United States during the years from 1916 to 1921, inclusive (372 tons), and is more than half as large as the average shipments from Peru (768 tons) in the five years ending with 1920. However, the percentage of the vanadium is small, and it is mixed with an element, phosphorus, from which separation is difficult, and so far as is known the problem of separating small quantities of vanadium from large quantities of phosphorus has not before been attacked. The fact that the vanadium is all held in solution during the treatment of the phosphate will probably make the separation easier, and the separation of small quantities of phosphorus from vanadium is now made on a commercial scale, so that phosphorus carried into the vanadium concentrate could be removed. Bodies of phosphate rock in Montpelier Canyon, Idaho, carrying 0.42 to 0.52 per cent of $V_2O_5$, have been described, and should such rock be worked it would

[12] Phosphate rock: U. S. Geol. Survey Mineral Resources, 1922, pt. 2, p. 116, 1923.

give a solution carrying one and one-half times the lower quantity, or 0.63 per cent of $V_2O_5$, practically twice that carried by the rock now worked, and would make the investigation still more attractive. The fact that vanadium in ferrovanadium is now worth about $3.50 to $4 a pound and at its lowest has averaged at least $2 a pound allows a considerable amount of work and expense in its isolation and makes the problem of separation sound very engaging, and it seems possible of solution.

Much the largest part of the vanadium ore imported into the United States has come from Peru, and nearly all the Peruvian ore has come from the deposit of Minaragra, owned by the Vanadium Corporation of America. The principal original ore mineral is patronite, a vanadium sulphide carrying an excess of sulphur. The ore mined is made up mostly of obscure oxidation products. During 1922 the mine at Minaragra was idle, as the company held very large stocks of ore in this country, and the demand was low. Ash made from asphaltite found in numerous dikes has also been imported in small quantity and in isolated lots. The ash carries 10 to 20 per cent of $V_2O_5$. In 1922 Peru produced 22 metric tons of the ash, carrying 17 per cent of $V_2O_5$, valued at 930 libras (1 libra (1922) =$3.87).[13]

Several hundred tons of lead vanadates have been imported at various times from the vicinity of Otavi, in what was formerly German Southwest Africa, now under the mandate of the Union of South Africa and called British Southwest Africa. Lead vanadates, principally mottramite, the lead-copper vanadate, have been mined in comparatively small quantities for a long time, but within the last few years descloizite has been found and shipped in much larger quantity. The ores are unusually massive, and pieces weighing more than 200 pounds have been taken out, one of which is in the United States National Museum. In the report of the director of the twelfth ordinary general meeting of the Otavi Exploring Syndicate (Ltd.), it was said:

> Deliveries under existing contract (which expires in October, 1924), pursuant to which the company sold its output of vanadium ores up to 50 tons per month, total to date 1,200 tons. The output remains at approximately 50 tons per month.

The ore is thought to carry about 10 per cent of vanadium.

Lead vanadates, largely vanadinite, are found at Broken Hill and a few other places in Northern Rhodesia. In 1922 158 short tons of such ore, valued at £5,926, was exported.[14] It carried possibly 10 per cent of vanadium, but some lots carry more than 1 per cent of arsenic and some phosphorus.

Vanadium is used principally as a component of steel. Added in small quantities (0.2 to 0.3 per cent) to steels it increases their toughness greatly, and vanadium steels are widely used in automobile and locomotive parts, both cast and forged. Spring steels are also greatly toughened by the addition of vanadium. Manufacturers of springs for automobiles have said that, by using vanadium, springs could be guaranteed for the life of the car; without it no such guaranty could

[13] Advance figures furnished through the courtesy of Dr. C. P. Jiminez, chief statistician, Cuerpo de ingenieros del Perú.

[14] Northern Rhodesia Chamber of Mines Ann. Rept. for 1922, 1923.

be given. Vanadium ranging from 0.7 to 1.3 per cent is widely used in high-speed tool steels. Steels for mining work and other steels are regularly made with vanadium.

Vanadium has been used in nonferrous alloys, but apparently not with the marked success that it has met in steel. There have been many minor uses for vanadium, in medicine, inks, dyes, etc., but they are unimportant compared with its use in steel.

*Approximate world's production of vanadium, 1918–1922.*

| Year. | Shipments of ore from countries other than United States. | | | United States vanadium content of ore and concentrates produced (short tons). | Total (short tons). |
|---|---|---|---|---|---|
| | Short tons. | Percentage of $V_2O_5$. | Vanadium contained (short tons). | | |
| 1918 | [a] 2,407 | 19.10 | 257 | 276 | 533 |
| 1919 | [a] 3,249 | 30.41 | 553 | 284 | 837 |
| 1920 | [a] 11,158 | 20.43 | 1,277 | 527 | 1,804 |
| 1921 | [a] 1,958 | 20.23 | 222 | 202 | 424 |
| 1922 | 782 | 17.18 | 78 | 26 | 104 |

[a] Peruvian ore only. During these years a little vanadium was produced in other countries, but the quantity was negligible.

The production of vanadium ores as represented by exports in foreign countries and shipments from the mines in this country was as follows in 1922:

*World's production of vanadium in 1922.*

| Country. | Ore (short tons). | Percentage of $V_2O_5$. | Vanadium content (short tons). |
|---|---|---|---|
| United States | 929 | 5 | 26 |
| Peru | 24 | 17 | 2 |
| British Southwest Africa | 600 | 17–18 | 60 |
| Northern Rhodesia | 158 | 17–18 | 16 |
| | 1,711 | ..... | 104 |

*Value of uranium salts and oxide, including some radium salts, imported for consumption in the United States, 1917–1922.*

| | | | |
|---|---|---|---|
| 1917 | $2,930 | 1920 | $3 |
| 1918 | 274 | 1921 | 8,552 |
| 1919 | 12,960 | 1922 | 28,685 |

*Uranium-radium ore (steel-hardening) imported for consumption in the United States, 1918–1922.*

| Year. | Pounds. | Value. | Year. | Pounds. | Value. |
|---|---|---|---|---|---|
| 1918—July to December [a] | 157 | $4,840 | 1921 | 250 | $446 |
| 1919 | ..... | ..... | 1922 | ..... | ..... |
| 1920 | 396 | 1,110 | | | |

[a] Not separately classified prior to July, 1918.

*Vanadium ore (steel-hardening) imported for consumption in the United States, 1918–1922.*

| Year. | Pounds. | Value. | Year. | Pounds. | Value. |
|---|---|---|---|---|---|
| 1918—July to December [a] | 1,772,215 | $5,333 | 1921 | 10,307,540 | $543,061 |
| 1919 | 6,026,005 | 67,846 | 1922 | 611,170 | 86,776 |
| 1920 | 20,673,296 | 1,080,935 | | | |

[a] Not separately classified prior to July, 1918.

During 1922 1,160 pounds of ferrovanadium, valued at $3,770, was imported for consumption, and 49,099 pounds, valued at $69,279, was exported.

# MANGANESE AND MANGANIFEROUS ORES.

By H. A. C. Jenison and H. M. Meyer.[1]

## SUMMARY.

A feature of interest to the manganese industry in 1922 was the enactment of the tariff on manganese. This act became effective in September, 1922, too late to affect materially the domestic market during the year. No quantitative data are yet available to show its effect, but it is supposed to have increased production in some districts. A paraphrased excerpt of the tariff act follows:

> Manganese ore or concentrates containing in excess of 30 per cent of metallic manganese, 1 cent per pound on the metallic content therein * * *. Ferromanganese containing more than 1 per cent carbon, 1⅞ cents per pound on the manganese contained: *Provided*, That ferromanganese for the purpose of this act shall be such iron-manganese alloys as contain 30 per cent or more of manganese.
> Iron ore, including manganiferous iron ore * * * [free].

The shipments of high-grade manganese ore (containing 35 per cent or more of manganese) during 1922 were 13,404 gross tons, compared with 13,531 gross tons in 1921. The average price received, however, was only $33.96 a ton, compared with $36.59 a ton in 1921. Montana, as usual, produced more than any other State, contributing 73 per cent of the total for the country, as compared with 82 per cent in 1921. The interest in manganese production after the tariff was put into effect increased at a greater rate in Arkansas, it is believed, than in any other State, and her production for the year amounted to about three times that of 1921. California and Nevada, which produced no manganese in 1921, made a small production in 1922. With the exception of the States named above and Virginia, which made a small increase in output, all the States contributing to the production decreased their output.

The shipments of ferruginous manganese ores (containing 10 to 35 per cent of manganese), exclusive of ore used for fluxing, showed an increase of 336,235 tons. This increase was due almost entirely to the output from Minnesota, which shipped none in 1921 but 305,093 gross tons in 1922. Prior to 1921 Minnesota had been the principal shipper of ore of this grade for several years, and in 1922 its shipments were about 89 per cent of the total for the country. The quantity of ore of this grade shipped for use in fluxing was 27,705 gross tons in 1922, compared with 22,962 gross tons in 1921. Nevada, which has for many years been a large shipper of manganiferous fluxing ores, shipped none in 1922.

The shipments of manganiferous iron ore (containing 5 to 10 per cent of manganese), exclusive of ore used for fluxing and mainly from the Cuyuna district of Minnesota, increased from 62,670 gross tons in 1921 to 251,614 tons in 1922. Minnesota shipped about 99 per cent of the total for the country.

[1] Statistics of imports and exports compiled by J. A. Dorsey, of the U. S. Geological Survey, from records of the Bureau of Foreign and Domestic Commerce.

## PRODUCTION AND IMPORTS.

*Manganese alloys and ore produced in the United States and imported from principal foreign sources, 1917–1922, in gross tons.*

| Year. | Steel (production).[a] | Ferromanganese. | | Spiegeleisen. | | Manganese ore. | | | | |
|---|---|---|---|---|---|---|---|---|---|---|
| | | Shipments. | Imports. | Shipments. | Imports. | Shipments.[b] | Total imports. | Imports from— | | |
| | | | | | | | | Russia. | India. | Brazil. |
| 1917 | 45,060,607 | 260,225 | 41,969 | 189,241 | 3,968 | 129,351 | 629,972 | ..... | 48,975 | 512,517 |
| 1918 | 44,462,432 | 306,076 | 27,168 | 263,861 | 1,969 | 305,869 | 491,303 | ..... | 29,275 | 345,877 |
| 1919 | 34,671,232 | 198,255 | 33,022 | 90,855 | 27 | 54,957 | 333,344 | 6,916 | 9,200 | 246,592 |
| 1920 | 42,132,934 | [c]276,594 | 59,254 | 103,672 | 5,234 | 94,420 | [d]599,764 | 18,762 | 71,238 | 421,523 |
| 1921 | 19,783,797 | [c]111,374 | 9,077 | [e]69,230 | 307 | 13,531 | [d]392,606 | ..... | 113,730 | 262,468 |
| 1922 | 35,602,926 | [c]161,612 | 95,007 | 70,253 | 8,151 | 13,404 | 374,451 | 1,642 | 24,548 | 275,193 |

[a] According to American Iron and Steel Institute.
[b] Exclusive of small quantities of ore shipped for use in fluxing.
[c] Includes a small quantity of silico-manganese.
[d] See table of imports, p. 590.
[e] Includes a small quantity of silico-spiegel.

For a discussion of manganese minerals and ore the reader is referred to the report on manganese and manganiferous ores in Mineral Resources for 1919.

*Manganese and manganiferous ore (exclusive of fluxing ore) shipped from mines in the United States in 1921 and 1922, by States.*

| State. | Ore containing 35 per cent of manganese or more. | | | Ore containing 10 to 35 per cent of manganese. | | | Ore containing 5 to 10 per cent of manganese. | | |
|---|---|---|---|---|---|---|---|---|---|
| | Number of shippers. | Gross tons. | Value. | Number of shippers. | Gross tons. | Value. | Number of shippers. | Gross tons. | Value. |
| **1921.** | | | | | | | | | |
| Arizona | 2 | 328 | (a) | ..... | ..... | ..... | ..... | ..... | ..... |
| Arkansas | 3 | 728 | $16,360 | 2 | 278 | $3,683 | ..... | ..... | ..... |
| Colorado | 1 | 490 | (a) | 1 | 924 | (a) | ..... | ..... | ..... |
| Georgia | ..... | ..... | ..... | 1 | 7,162 | (a) | 1 | 6,140 | (a) |
| Michigan | ..... | ..... | ..... | 1 | 51 | (a) | ..... | ..... | ..... |
| Minnesota | ..... | ..... | ..... | ..... | ..... | ..... | 2 | 56,530 | (a) |
| Montana | 3 | 11,129 | 444,981 | ..... | ..... | ..... | ..... | ..... | ..... |
| Tennessee | 1 | 139 | 3,396 | 1 | 24 | 257 | ..... | ..... | ..... |
| Virginia | 4 | 717 | 15,549 | ..... | ..... | ..... | ..... | ..... | ..... |
| Undistributed | ..... | ..... | 14,811 | ..... | ..... | 38,815 | ..... | ..... | $147,576 |
| | 14 | 13,531 | 495,097 | 6 | 8,439 | 42,755 | 3 | 62,670 | 147,576 |
| Total, 1920 | 56 | 94,420 | 2,396,235 | 31 | 357,279 | 1,450,518 | 6 | 279,687 | 644,572 |
| Total, 1919 | 42 | 54,957 | 1,791,118 | 24 | 211,632 | 965,660 | 9 | 112,303 | 352,570 |
| **1922.** | | | | | | | | | |
| Alabama | ..... | ..... | ..... | 1 | 475 | 1,900 | ..... | ..... | ..... |
| Arizona | 2 | 203 | 2,572 | ..... | ..... | ..... | ..... | ..... | ..... |
| Arkansas | 9 | 2,264 | 42,197 | ..... | ..... | ..... | ..... | ..... | ..... |
| California | 1 | (a) | (a) | ..... | ..... | ..... | ..... | ..... | ..... |
| Georgia | ..... | ..... | ..... | 1 | 839 | (a) | 1 | 194 | (a) |
| Michigan | ..... | ..... | ..... | 2 | 9,644 | (a) | ..... | ..... | ..... |
| Minnesota | ..... | ..... | ..... | 3 | 305,093 | 940,311 | 4 | 248,560 | 622,278 |
| Montana | 3 | 9,751 | 371,245 | ..... | ..... | ..... | ..... | ..... | ..... |
| Nevada | 1 | (a) | (a) | ..... | ..... | ..... | ..... | ..... | ..... |
| New Mexico | ..... | ..... | ..... | 2 | 28,623 | (a) | ..... | ..... | ..... |
| Tennessee | 1 | 113 | 1,636 | ..... | ..... | ..... | ..... | ..... | ..... |
| Virginia | 1 | 800 | (a) | ..... | ..... | ..... | ..... | ..... | ..... |
| Wisconsin | ..... | ..... | ..... | ..... | ..... | ..... | 1 | 2,860 | (a) |
| Undistributed | ..... | 273 | 37,510 | ..... | ..... | 129,569 | ..... | ..... | 9,761 |
| | 18 | 13,404 | 455,160 | 9 | 344,674 | 1,071,780 | 6 | 251,614 | 632,039 |

[a] Included under "Undistributed." Geological Survey not at liberty to publish.

The figures in the following table are taken from Mineral Resources as far as possible and from the best other available sources. Montana has made the largest production, 36 per cent of the total for the country, almost entirely since 1916. Virginia, the next in rank, has produced 27 per cent of the total, principally prior to 1916. Georgia is third, with 10 per cent; Arkansas fourth, with 8 per cent; and California fifth, with 7 per cent. Arizona and California each produced more manganese ore during the period 1917–1922 than either Virginia, Georgia, or Arkansas.

*Manganese ore (containing 35 per cent of manganese or more) produced[a] in the United States, 1838–1922, in gross tons.*

| State. | 1838–1916[b] | 1917 | 1918 | 1919 | 1920 | 1921 | 1922 | Total, 1838–1922[b] |
|---|---|---|---|---|---|---|---|---|
| Alabama | 314 | 264 | 709 | 40 | 57 | ..... | ..... | 1,384 |
| Arizona | 3,399 | 14,802 | 17,612 | 529 | 2,402 | 328 | 203 | 39,275 |
| Arkansas | 57,482 | 10,140 | 7,731 | 2,558 | 3,445 | 728 | 2,264 | 84,348 |
| California | 22,036 | 14,196 | 24,067 | 11,289 | 1,733 | ..... | (c) | c 73,576 |
| Colorado | 260 | 60 | 4,821 | 11,166 | 3,643 | 490 | ..... | 20,440 |
| Georgia | 99,516 | 3,614 | 6,679 | 48 | 341 | ..... | ..... | 110,198 |
| Indian Territory (Oklahoma) | 206 | ..... | ..... | ..... | ..... | ..... | ..... | 206 |
| Michigan | 137 | ..... | ..... | ..... | ..... | ..... | ..... | 137 |
| Missouri | 44 | ..... | ..... | ..... | ..... | ..... | ..... | 44 |
| Montana | 6,555 | 61,109 | 199,932 | 24,993 | 76,441 | 11,129 | 9,751 | 389,910 |
| Nevada | 345 | 3,450 | 19,872 | 78 | 1,240 | ..... | (c) | c 25,003 |
| New Jersey | ..... | ..... | 64 | ..... | ..... | ..... | ..... | 64 |
| New Mexico | ..... | 2,603 | 3,126 | ..... | 2,053 | ..... | ..... | 7,782 |
| North Carolina | 181 | 102 | 315 | ..... | ..... | ..... | ..... | 598 |
| Oregon | ..... | ..... | 198 | ..... | ..... | ..... | ..... | 198 |
| Pennsylvania | 1,113 | ..... | ..... | ..... | ..... | ..... | ..... | 1,113 |
| South Carolina | 1,367 | 405 | 100 | ..... | ..... | ..... | ..... | 1,872 |
| South Dakota | 19 | ..... | 31 | ..... | ..... | ..... | ..... | 50 |
| Tennessee | 3,054 | 1,996 | 4,162 | 328 | 502 | 139 | 113 | 10,294 |
| Texas | ..... | 25 | 380 | ..... | ..... | ..... | ..... | 405 |
| Utah | 5,177 | 4,195 | 5,100 | ..... | ..... | ..... | ..... | 14,472 |
| Vermont | 1,625 | ..... | ..... | ..... | ..... | ..... | ..... | 1,625 |
| Virginia | 254,377 | 12,360 | 10,928 | 3,928 | 2,523 | 717 | 800 | 285,633 |
| West Virginia and other States | 1,198 | ..... | ..... | ..... | ..... | ..... | c 273 | c 1,198 |
| Wyoming | ..... | 30 | 42 | ..... | 40 | ..... | ..... | 112 |
| | 458,405 | 129,351 | 305,869 | 54,957 | 94,420 | 13,531 | 13,404 | 1,069,937 |

[a] Beginning with 1910 figures represent shipments and exclude fluxing ore.

[b] Prior to 1916 some States in some years produced insignificant quantities of manganese ore. Some of these quantities could not be published separately without disclosing confidential information, so they were included with totals for other States. The quantities so included are more or less compensating and are too small to affect State totals materially.

[c] Output of California and Nevada included under "West Virginia and other States" for 1922. Geological Survey not at liberty to publish. These tonnages, however, are included under the proper State in the total for 1838–1922.

*Manganese and manganiferous ore shipped from mines in the United States, 1910–1922, in gross tons.*

| Year. | Manganese and manganiferous ores exclusive of fluxing ore. | | | Fluxing ore containing manganese. | | |
|---|---|---|---|---|---|---|
| | Ore containing 35 per cent of manganese or more. | Ore containing 10 to 35 per cent of manganese. | Ore containing 5 to 10 per cent of manganese. | Ore containing 35 per cent of manganese or more. | Ore containing 10 to 35 per cent of manganese. | Ore containing 5 to 10 per cent of manganese. |
| 1910 | 2,258 | | | | 41,260 | 19,841 |
| 1911 | 2,457 | 2,602 | 82 | | 34,982 | 6,771 |
| 1912 | 1,664 | 2,782 | 117 | | 38,081 | 10,537 |
| 1913 | 4,048 | 9,650 | | | 41,862 | 7,891 |
| 1914 | 2,635 | 60,484 | | | 31,182 | 6,599 |
| 1915 | 9,558 | 64,204 | 10,616 | 55 | 116,749 | [a] 4,166 |
| 1916 | 31,474 | 316,600 | 81,615 | | 137,253 | [b] 8,858 |
| 1917 | 129,351 | 576,608 | 108,409 | 54 | 154,151 | [c] 21,776 |
| 1918 | 305,869 | 818,003 | 236,103 | | 98,160 | [d] 18,196 |
| 1919 | 54,957 | 211,632 | 112,303 | 365 | 98,202 | [e] 11,596 |
| 1920 | 94,420 | 357,279 | 279,687 | | 123,970 | [f] 6,728 |
| 1921 | 13,531 | 8,439 | 62,670 | | 22,962 | [g] 3,028 |
| 1922 | 13,404 | 344,674 | 251,614 | 2,278 | 27,705 | [h] 1,666 |
| | 665,626 | 2,772,957 | 1,143,216 | 2,752 | 966,519 | 127,653 |

[a] Includes 796 tons of ore containing less than 5 per cent of manganese.
[b] Includes 1,026 tons of ore containing less than 5 per cent of manganese.
[c] Includes 141 tons of ore containing less than 5 per cent of manganese.
[d] Includes 1,684 tons of ore containing less than 5 per cent of manganese.
[e] Includes 844 tons of ore containing less than 5 per cent of manganese.
[f] Includes 1,250 tons of ore containing less than 5 per cent of manganese.
[g] Includes 998 tons of ore containing less than 5 per cent of manganese.
[h] Includes 117 tons of ore containing less than 5 per cent of manganese.

*Ferruginous manganese and manganiferous iron ores shipped from the Cuyuna district, Minn., 1917–1922, and total, 1913-1922, in gross tons.*

| Mine. | Ore containing 10 to 35 per cent of manganese. | | | | | |
|---|---|---|---|---|---|---|
| | 1917 | 1918 | 1919 | 1920 | 1921 | 1922 |
| Algoma (Hoch) | [a] 84,125 | 21,200 | 21,478 | [b] 5,115 | | |
| Arko | | 733 | 500 | 2,044 | | |
| Cuyuna Mille Lacs | 112,554 | 132,515 | | | | |
| Ferro | (a) | 57,261 | 14,556 | | | |
| Gloria | | | 2,637 | 738 | | |
| Hillcrest | | | | | | |
| Hopkins | | 36,651 | 5,849 | | | |
| Ida Mae | | 5,134 | | [b] 20,851 | | |
| Joan Nos. 1 and 4 | 8,375 | 27,931 | | 8,500 | | |
| Kennedy | | | | | | |
| Mahnomen | 4,000 | 132,726 | 11,472 | 9,842 | | 69,644 |
| Mangan Nos. 1 and 2 | 52,290 | 67,796 | 92 | 10,979 | | |
| Martin | | 349 | | | | |
| Merritt Nos. 1 and 2 | 33,180 | 78,555 | | 33,239 | | |
| Portsmouth | | | | | | 38,000 |
| Sagamore | | | 79,248 | 163,904 | | 197,449 |
| Sultana | 65,018 | 64,158 | 120 | [b] 38,312 | | |
| | 359,542 | 625,009 | 138,952 | 293,524 | | 305,093 |

[a] Shipments from Ferro mine included with Algoma mine for 1917. Not reported separately to the Geological Survey.
[b] According to the Iron Trade Review.

*Ferruginous manganese and manganiferous iron ores shipped from the Cuyuna district, Minn.*—Continued.

| Mine. | Ore containing 5 to 10 per cent of manganese. | | | | | | Total, 1913–1922. |
|---|---|---|---|---|---|---|---|
| | 1917 | 1918 | 1919 | 1920 | 1921 | 1922 | |
| Algoma (Hoch) | ..... | ..... | ..... | ..... | ..... | ..... | [a] 165,710 |
| Arko | ..... | ..... | ..... | ..... | ..... | ..... | 3,277 |
| Cuyuna Mille Lacs | ..... | 25,560 | ..... | ..... | ..... | ..... | 477,050 |
| Ferro | ..... | ..... | ..... | ..... | ..... | ..... | [a] 86,527 |
| Gloria | ..... | ..... | ..... | ..... | ..... | ..... | 3,375 |
| Hillcrest | 9,590 | 20,242 | ..... | ..... | 15,473 | 4,100 | 52,117 |
| Hopkins | ..... | ..... | ..... | ..... | ..... | ..... | 42,500 |
| Ida Mae [c] | ..... | ..... | ..... | ..... | ..... | 870 | 26,855 |
| Joan Nos. 1 and 4 | ..... | ..... | ..... | ..... | ..... | ..... | 44,806 |
| Kennedy | ..... | ..... | ..... | 9,511 | ..... | ..... | 9,511 |
| Mahnomen | 82,000 | 175,648 | 90,896 | 81,066 | 41,057 | 110,590 | 851,941 |
| Mangan Nos. 1 and 2 | ..... | 4,679 | ..... | ..... | ..... | ..... | 166,165 |
| Martin | ..... | 1,073 | ..... | ..... | ..... | ..... | 1,422 |
| Merritt Nos. 1 and 2 | ..... | ..... | ..... | ..... | ..... | ..... | 144,974 |
| Portsmouth | ..... | ..... | ..... | 158,336 | ..... | 133,000 | 329,336 |
| Sagamore | ..... | ..... | 7,324 | ..... | ..... | ..... | 447,925 |
| Sultana | ..... | ..... | ..... | ..... | ..... | ..... | 202,978 |
| | 91,590 | 227,202 | 98,220 | 248,913 | 56,530 | 248,560 | 3,056,469 |

[a] Shipments from Ferro mine included with Algoma mine for 1917. Not reported separately to the Geological Survey.
[c] The Whitmarsh Mining Co. acquired the Ida Mae mine in 1922 and renamed it "Milford."

*Manganiferous silver ore shipped from mines in the United States, 1917–1922, in gross tons.*[a]

| Year. | Arizona. | Colorado. | | Montana. | Nevada. | New Mexico. | Utah. |
|---|---|---|---|---|---|---|---|
| | | For fluxing. | For other purposes. | | | | |
| 1917 | 32,409 | 20,600 | 104,115 | ..... | 122,872 | ..... | 100 |
| 1918 | 10,854 | 24,931 | 99,110 | ..... | 80,096 | 475 | ..... |
| 1919 | 1,964 | 29,769 | 11,055 | ..... | 77,815 | 250 | ..... |
| 1920 | 345 | 31,670 | 11,056 | ..... | 95,142 | 541 | ..... |
| 1921 | ..... | 10,819 | 924 | ..... | 14,871 | 300 | ..... |
| 1922 | ..... | 13,951 | ..... | 6,656 | ..... | 8,764 | ..... |

[a] All used for fluxing except that from Colorado designated "For other purposes."

*Manganese ore imported into the United States, 1920–1922.*

| Country. | 1920 | | 1921 | |
|---|---|---|---|---|
| | Gross tons. | Value. | Gross tons. | Value. |
| Africa | 31,927 | $123,415 | 8,453 | $27,198 |
| Argentina | (a) | (a) | (a) | (a) |
| Australia | | | (b) | 8 |
| Brazil | 421,523 | 8,833,493 | 262,468 | 1,952,848 |
| Canada | 828 | 28,509 | (a) | (a) |
| Chile | 12,563 | 312,794 | | |
| China | 3,383 | 126,648 | | |
| Costa Rica | 2,413 | 60,325 | 588 | 17,658 |
| Cuba | 8,247 | 266,744 | 34 | 679 |
| Czechoslovakia | 1,874 | 58,602 | | |
| France | (a) | (a) | | |
| Germany | (a) | (a) | (a) | (a) |
| Honduras | | | 14 | 140 |
| Hongkong | 9,520 | 207,441 | 7,319 | 131,052 |
| India (British) | 71,238 | 551,660 | 113,730 | 73,516 |
| Japan | (a) | (a) | (a) | (a) |
| Mexico | 2,925 | 55,449 | | |
| Oceania (French) | 7,510 | 75,316 | | |
| Russia | 18,762 | 858,804 | | |
| Turkey | (a) | (a) | | |
| United Kingdom | 7,049 | 243,564 | (a) | (a) |
| Venezuela | 2 | 111 | | |
| | a 599,764 | a 11,802,875 | a 392,606 | a 2,864,099 |

| Country. | 1922 | | | | | |
|---|---|---|---|---|---|---|
| | Jan. 1 to Sept. 21. | | Sept. 22 to Dec. 31. | | Total. | |
| | Gross tons. | Value. | Gross tons. | Value. | Gross tons. | Value. |
| Africa (British): | | | | | | |
| South | 5,998 | $21,891 | | | 5,998 | $21,891 |
| West | 22,701 | 106,223 | | | 22,701 | 106,223 |
| Belgium | | | 528 | $18,956 | 528 | 18,956 |
| Brazil | 234,598 | 2,025,505 | 40,595 | 469,938 | 275,193 | 2,495,443 |
| Canada | 60 | 2,208 | 67 | 3,619 | 127 | 5,827 |
| China | 2 | 46 | 1 | 67 | 3 | 113 |
| Cuba | 12,568 | 89,677 | | | 12,568 | 89,677 |
| England | 448 | 18,242 | 1,093 | 74,429 | 1,541 | 92,671 |
| Germany | 41 | 3,259 | 52 | 5,131 | 93 | 8,390 |
| Hongkong | | | 1,243 | 28,677 | 1,243 | 28,677 |
| India (British) | 24,250 | 82,016 | 298 | 4,793 | 24,548 | 86,809 |
| Java and Madura | | | 205 | 10,250 | 205 | 10,250 |
| Mexico | 500 | 10,000 | | | 500 | 10,000 |
| Panama | (b) | 19 | | | (b) | 19 |
| Turkey in Europe | 26,561 | 336,638 | 1,000 | 50,000 | 27,561 | 386,638 |
| Ukraine | | | 1,642 | 38,180 | 1,642 | 38,180 |
| | 327,727 | 2,695,724 | 46,724 | 704,040 | 374,451 | 3,399,764 |

a In 1920 7,173 gross tons, valued at $428,047, ranging in value from $50 to $292 per ton, and in 1921 8,748 tons, valued at $501,633, ranging in value from $46 to $128 per ton, were also reported by the Bureau of Foreign and Domestic Commerce as imports of manganese ore from countries designated "a." It is extremely unlikely that manganese ore could have been valued so highly as these statistics indicate; consequently these figures probably represent imports of ferromanganese, spiegeleisen, manganese chemicals, and perhaps some chemical ore. Exact determination of the character of this material is impossible.
b Less than 1 ton.

## MANGANIFEROUS ZINC RESIDUUM.

Manganiferous zinc residuum containing 12 to 15 per cent of manganese and 40 per cent of iron was recovered, as in former years, from the roasted franklinite concentrates at Franklin Furnace, N. J., and was smelted to spiegeleisen.

*Manganiferous residuum produced from zinc roasting in the United States and shipped, 1916–1922, in gross tons.*

| | | | |
|---|---|---|---|
| 1916 | 198,817 | 1920 | 133,602 |
| 1917 | 155,332 | 1921 | 12,627 |
| 1918 | 146,796 | 1922 | 81,333 |
| 1919 | 80,418 | | |

## FERROMANGANESE AND SPIEGELEISEN.

For a discussion of the manufacture, specifications, and uses of ferromanganese and spiegeleisen the reader is referred to the report on manganese and manganiferous ores in Mineral Resources for 1919.

The firms that make ferromanganese and spiegeleisen are listed below (f indicates ferromanganese; s, spiegeleisen):

fs—American Manganese Manufacturing Co., Dunbar, Pa.
f—Anaconda Copper Mining Co., Great Falls, Mont.
f—Bethlehem Steel Corporation, Sparrows Point, Md., and Lackawanna, N. Y.
fs—Bethlehem Steel Corporation, Lebanon, Pa.
fs—Cambria Steel Co., Widener Building, Philadelphia, Pa.
f—Electro Metallurgical Co., Niagara Falls, N. Y.
fs—Juniata Furnace & Foundry Co., Newport, Pa.
f—Lavino Furnace Co., Marietta and Sheridan, Pa.
f—E. E. Marshall, Harrisburg, Pa.
s—New Jersey Zinc Co., Palmerton, Pa.
f—Steel & Tube Co. of America, South Chicago, Ill.
f—Tennessee Coal, Iron & Railroad Co., Bessemer, Ala.
f—United States Steel Corporation, Etna, Neville Island, and Pittsburgh, Pa.
s—United States Steel Corporation, Etna, North Braddock, and Pittsburgh, Pa.

Some question has recently arisen about the change in the quantity of ferroalloys used in steel production and the source of the manganese ore from which ferroalloys were made that are being used at the present time. The following tables, prepared by D. F. Hewett, of the United States Geological Survey, throw considerable light upon this question. In the preparation of these tables stocks have necessarily been disregarded, and consequently some error has been introduced in the calculation of the quantity of alloys and metallic manganese used in the production of steel. In the main, however, the tables show clearly the present tendencies of the industry.

*Trend of consumption of ferromanganese and spiegeleisen in the United States, 1913–1922.*

| Year. | Steel produced (tons). | Ferromanganese (tons). | | | | Spiegeleisen (tons). | | | | Total metallic manganese. | Ferromanganese per ton of steel (pounds). | Manganese in ferromanganese per ton of steel (pounds). | Total manganese per ton of steel (pounds). | Percentage of total manganese as spiegeleisen. |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | Shipments. | Imports. | Total. | Metallic manganese. | Shipments. | Imports. | Total. | Metallic manganese. | | | | | |
| 1913 | 31,300,874 | 119,495 | 128,070 | 247,565 | 196,798 | 106,980 | 77 | 107,057 | 20,860 | 217,658 | 16.2 | 12.8 | 14.3 | 10.5 |
| 1914 | 23,513,030 | 100,731 | 82,997 | 183,728 | 145,806 | 76,625 | 2,870 | 79,495 | 16,306 | 162,112 | | | | |
| 1915 | 32,151,036 | 144,260 | 55,263 | 199,523 | 153,098 | 114,556 | 200 | 114,756 | 21,149 | 174,247 | | | | |
| 1916 | 42,773,680 | 224,103 | 90,928 | 315,031 | 241,370 | 182,837 | ..... | 182,837 | 40,780 | 282,150 | | | | |
| 1917 | 45,060,607 | 260,225 | 41,969 | 302,194 | 237,463 | 189,241 | 3,968 | 193,209 | 40,808 | 278,271 | 15.9 | 11.7 | 13.8 | 14.7 |
| 1918 | 44,462,432 | 306,076 | 27,168 | 333,244 | 234,553 | 263,861 | 1,969 | 265,830 | 51,900 | 286,453 | | | | |
| 1919 | 34,671,232 | 198,255 | 33,022 | 231,277 | 162,251 | 90,855 | 27 | 90,882 | 17,691 | 179,942 | | | | |
| 1920 | 42,132,934 | 276,594 | 59,254 | 335,848 | 241,693 | 103,672 | 5,234 | 108,906 | 21,593 | 263,286 | | | | |
| 1921 | 19,783,797 | 111,374 | 9,077 | 120,451 | 92,676 | 69,230 | 307 | 69,537 | 11,765 | 104,441 | 16.4 | 12.3 | 13.4 | 7.9 |
| 1922 | 35,602,926 | 161,612 | 95,007 | 256,619 | 202,119 | 70,253 | 8,151 | 78,404 | 12,378 | 214,497 | | | | |
| | 351,452,548 | 1,902,725 | 622,755 | 2,525,480 | 1,907,827 | 1,268,110 | 22,803 | 1,290,913 | 255,230 | 2,163,057 | 16.1 | 12.2 | 13.8 | 11.8 |

*Relation of ore supplies to ferromanganese produced in the United States, 1913–1922.*

| Year. | Ore (tons). | | | | | Ferromanganese made (tons). | Tons of ore per ton of ferromanganese. | Manganese in domestic ferromanganese (tons). | Tons of ore per ton of manganese. |
|---|---|---|---|---|---|---|---|---|---|
| | Imported. | Shipped. | Total. | Battery ore. | Total less battery ore. | | | | |
| 1913 | 345,090 | 4,048 | 349,138 | 20,000 | 329,138 | 119,495 | 2.47 | 94,342 | 3.15 |
| 1914 | 283,294 | 2,635 | 285,929 | 20,000 | 265,929 | 100,731 | | 79,408 | |
| 1915 | 320,778 | 9,558 | 330,336 | 20,000 | 310,336 | 145,842 | | 113,378 | |
| 1916 | 576,321 | 31,474 | 607,795 | 20,000 | 587,795 | 227,801 | 2.47 | 171,051 | 3.47 |
| 1917 | 629,972 | 129,351 | 759,323 | 25,000 | 734,323 | 250,270 | | 193,079 | |
| 1918 | 491,303 | 305,869 | 797,172 | 30,000 | 767,172 | 318,948 | | 220,771 | |
| 1919 | 333,344 | 54,957 | 388,301 | 30,000 | 358,301 | 185,893 | | 120,163 | |
| 1920 | [a] 599,764 | 94,420 | 694,184 | 35,000 | 659,184 | 294,602 | 2.52 | 209,496 | 3.40 |
| 1921 | [a] 392,606 | 13,531 | 406,137 | 30,000 | 376,137 | 104,129 | | 79,319 | |
| 1922 | 374,451 | 13,404 | 387,855 | 40,000 | 347,855 | 150,010 | | 117,833 | |

[a] See table of imports, p. 590.

*Ferromanganese and spiegeleisen shipped from furnaces in the United States, 1916–1922.*

| Year. | Ferromanganese. | | Spiegeleisen. | |
|---|---|---|---|---|
| | Gross tons. | Value. | Gross tons. | Value. |
| 1916 | 224,103 | $30,123,493 | 182,837 | $6,158,202 |
| 1917 | 260,225 | 53,930,771 | 189,241 | 9,756,236 |
| 1918 | 306,076 | 69,045,678 | 263,861 | 17,276,494 |
| 1919 | 198,255 | 27,093,816 | 90,855 | 3,965,754 |
| 1920 | [a] 276,594 | 41,840,690 | 103,672 | 5,289,049 |
| 1921 | [a] 111,374 | 13,654,800 | [b] 69,230 | 2,838,692 |
| 1922 | [a] 161,612 | 10,673,638 | 70,253 | 2,162,836 |

[a] Includes a small quantity of silico-manganese.
[b] Includes a small quantity of silico-spiegel.

*Ferromanganese and spiegeleisen imported for consumption in the United States, 1916–1922.*

| Year. | Ferromanganese. | | Spiegeleisen. | |
|---|---|---|---|---|
| | Gross tons. | Value. | Gross tons. | Value. |
| 1916 | 90,928 | $9,240,528 | | |
| 1917 | 41,969 | 5,710,988 | 3,968 | $291,594 |
| 1918 | 27,168 | 4,258,745 | 1,969 | 228,012 |
| 1919 | 33,022 | 4,283,541 | 27 | 1,018 |
| 1920 | 59,254 | 7,775,278 | 5,234 | 277,900 |
| 1921 | 9,077 | 888,419 | 307 | 10,472 |
| 1922 | 95,007 | 6,125,469 | 8,151 | 268,135 |

The following records of average contract prices of ferromanganese and of spiegeleisen by months for the last five years show a wide range. The ferromanganese prices are prices for material delivered at Pittsburgh; the prices of spiegeleisen are prices at producers' furnaces. (See also fig. 15.) Prices on ferromanganese from May, 1918, to and including January, 1919, are based on 70 per cent of manganese and other prices on 80 per cent; prices on spiegeleisen from April, 1918, to and including June, 1919, are based on 16 per cent of manganese and other prices on 20 per cent.

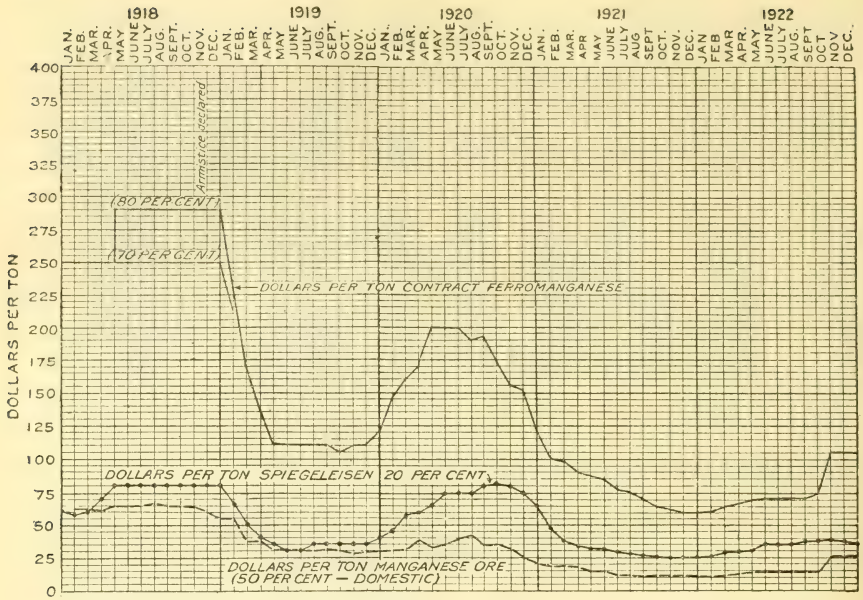



FIGURE 15.—Contract prices of ferromanganese, spiegeleisen, and manganese ore, 1918–1922.

*Prices per gross ton of ferromanganese, spiegeleisen, and manganese ore, 1918–1922.*[a]

| Month. | Ferromanganese. | | | | | Spiegeleisen. | | | | |
|---|---|---|---|---|---|---|---|---|---|---|
| | 1918 | 1919 | 1920 | 1921 | 1922 | 1918 | 1919 | 1920 | 1921 | 1922 |
| January | $250.00 | $212.50 | $146.00 | $101.00 | $61.90 | $59.00 | $67.50 | $46.60 | $46.25 | $25.50 |
| February | 250.00 | 165.00 | 160.00 | 96.85 | 65.32 | 59.00 | 52.50 | 57.60 | 37.75 | 28.00 |
| March | 250.00 | 134.00 | 172.00 | 89.00 | 67.82 | 65.50 | 42.50 | 60.40 | 34.20 | 28.00 |
| April | 250.00 | 113.75 | 200.00 | 87.50 | 69.07 | 70.00 | 34.50 | 66.85 | 32.00 | 30.00 |
| May | 250.00 | 110.00 | 200.00 | 83.00 | 72.32 | 71.00 | 31.35 | 75.00 | 31.75 | 35.00 |
| June | 250.00 | 111.75 | 198.00 | 76.50 | 72.82 | 75.00 | 27.50 | 75.00 | 29.60 | 35.25 |
| July | 250.00 | 111.00 | 190.00 | 75.00 | 72.29 | 75.00 | 34.00 | 75.00 | 27.50 | 35.00 |
| August | 250.00 | 110.00 | 193.75 | 70.75 | 72.29 | 75.00 | 34.00 | 79.35 | 26.20 | 37.00 |
| September | 250.00 | 105.00 | 172.40 | 64.75 | 80.59 | 75.00 | 34.00 | 82.00 | 25.25 | 38.00 |
| October | 250.00 | 110.00 | 156.40 | 61.65 | 105.47 | 75.00 | 34.00 | 80.00 | 24.85 | 37.75 |
| November | 250.00 | 110.00 | 153.00 | 60.00 | 104.91 | 75.00 | 34.00 | 74.35 | 25.00 | 36.80 |
| December | 236.00 | 121.00 | 120.00 | 60.00 | 104.91 | 72.50 | 39.00 | 64.40 | 25.00 | 35.75 |

| Month. | Manganese ore. | | | | |
|---|---|---|---|---|---|
| | 1918 | 1919 | 1920 | 1921 | 1922 |
| January | $63.75 | $55.50 | $30.00 | $18.75 | $10.50 |
| February | 63.75 | 38.75 | 38.75 | 17.50 | 11.00 |
| March | 60.00 | 37.50 | 38.75 | 17.25 | 12.50 |
| April | 65.00 | 30.00 | 32.25 | 14.00 | 12.75 |
| May | 65.00 | 30.00 | 35.00 | 14.00 | 12.75 |
| June | 65.00 | 30.00 | 37.50 | 12.50 | 13.25 |
| July | 68.50 | 31.25 | 42.25 | 12.50 | 13.50 |
| August | 65.00 | 31.25 | 35.00 | 12.50 | 13.75 |
| September | 65.00 | 30.00 | 35.00 | 12.50 | 14.35 |
| October | 65.00 | 27.50 | 32.75 | 12.50 | 25.50 |
| November | 62.50 | 27.50 | 25.00 | 12.50 | 25.50 |
| December | 55.00 | 27.50 | 21.25 | 12.00 | 25.50 |

[a] Iron Trade Review.

# GOLD AND SILVER.

(GENERAL REPORT.)

By J. P. Dunlop.

## PRODUCTION.

### DOMESTIC PRODUCTION.

*Approximate distribution, by producing States and Territories, of the production of gold and silver in the United States in 1922.*

[Figures supplied by U. S. Bureau of the Mint.]

| State or Territory. | Gold. | | Silver (fine ounces and dollars).[b] |
|---|---|---|---|
| | Fine ounces. | Value.[a] | |
| Alaska | 345,630 | $7,144,800 | 770,232 |
| Arizona | 169,704 | 3,508,100 | 4,627,738 |
| California | 712,157 | 14,721,600 | 3,095,480 |
| Colorado | 324,456 | 6,707,100 | 6,018,781 |
| Georgia | 140 | 2,900 | 394 |
| Idaho | 22,891 | 473,200 | 5,791,413 |
| Illinois | ..... | ..... | 4,612 |
| Michigan | ..... | ..... | 360,811 |
| Missouri | ..... | ..... | 118,655 |
| Montana | 73,443 | 1,518,200 | 9,682,304 |
| Nevada | 160,044 | 3,308,400 | 8,287,704 |
| New Mexico | 19,553 | 404,200 | 764,031 |
| North Carolina | 73 | 1,500 | 8 |
| Oregon | 23,728 | 490,500 | 150,347 |
| Pennsylvania | 116 | 2,400 | 2,141 |
| Philippine Islands | 73,840 | 1,526,400 | 27,994 |
| South Carolina | 5 | 100 | ..... |
| South Dakota | 320,402 | 6,623,300 | 121,427 |
| Tennessee | 218 | 4,500 | 76,885 |
| Texas | 19 | 400 | 653,657 |
| Utah | 107,175 | 2,215,500 | 15,465,202 |
| Virginia | 34 | 700 | 6 |
| Washington | 9,394 | 194,200 | 219,398 |
| Wyoming | 53 | 1,100 | 828 |
| | 2,363,075 | 48,849,100 | 56,240,048 |

[a] Gold valued at $20.67+ per fine ounce.
[b] Silver valued at $1 per fine ounce as provided by the Pittman Act of Apr. 23, 1918.

The figures in this table were obtained through cooperation between the United States Bureau of the Mint and the United States Geological Survey and were agreed upon after conference and adjustment between the two bureaus. They are therefore final for both.

The totals are based on bullion deposits in the United States mints and assay offices and on returns to the Bureau of the Mint from the smelting and refining companies. The distribution is adjusted by means of information collected by the United States Geological Survey directly from the producing mines and tabulated for the mine reports later discussed. The data for the total production and in part for the distribution are obtained from records of (1) the unrefined domestic gold and silver deposited in United States mints and assay offices, (2) the domestic gold and silver in fine bars reported

by private refineries, and (3) the unrefined domestic gold and silver contained in ores and matte exported for reduction. The last item is small.

*Increase or decrease in production of gold and silver in the United States in 1922.*

| | Gold. | | Silver (fine ounces and dollars). |
|---|---|---|---|
| | Fine ounces. | Value. | |
| Alabama | −4 | −$100 | −4 |
| Alaska | −41,297 | −853,700 | +16,233 |
| Arizona | +9,206 | +190,300 | +2,108,538 |
| California | −16,433 | −339,700 | −511,228 |
| Colorado | −31,003 | −640,700 | −291,913 |
| Georgia | +87 | +1,800 | +391 |
| Idaho | −3,338 | −69,000 | −1,408,906 |
| Illinois | | | +2,996 |
| Maine | −9 | −200 | |
| Michigan | | | +44,260 |
| Missouri | | | +55,185 |
| Montana | −10,033 | −207,400 | +5,284 |
| Nevada | +4,253 | +87,900 | +1,288,930 |
| New Mexico | +9,729 | +201,100 | +184,657 |
| North Carolina | −9 | −200 | −5 |
| Oregon | −15,726 | −325,100 | +97,229 |
| Pennsylvania | +92 | +1,900 | +434 |
| Philippine Islands | +13,135 | +271,500 | +1,602 |
| South Carolina | +5 | +100 | |
| South Dakota | +4,852 | +100,300 | +9,757 |
| Tennessee | −23 | −500 | −29,779 |
| Texas | −97 | −2,000 | +104,830 |
| Utah | +15,539 | +321,200 | +1,436,541 |
| Virginia | +5 | +100 | −2 |
| Washington | +2,085 | +43,100 | +71,814 |
| Wyoming | +53 | +1,100 | +763 |
| | −58,931 | −1,218,200 | +3,187,607 |

Domestic smelters and refiners produced 725,281 fine ounces of gold and 64,180,927 fine ounces of silver from foreign ores and bullion, an increase of 120,676 ounces of gold and of 13,362,290 ounces of silver compared with the corresponding figures for 1921. The foreign ores came mainly from Mexico, Canada, and Peru.

The value of the new gold used in the arts and industries in the United States in 1922 was $36,321,649, compared with $23,050,232 in 1921, and the quantity of new silver used for such purposes was 31,286,531 fine ounces, compared with 28,843,628 ounces. The consumption of new silver in the arts and industries in 1922 was equal to 55.6 per cent of the domestic production, and that of gold to 74 per cent of the domestic production. In addition to the gold and silver derived from foreign and domestic ores and bullion $23,484,403 in gold and 6,623,568 fine ounces of silver were recovered from old jewelry, dental waste, silverware, and other old material.

## PRICES OF SILVER.

The average monthly prices of foreign fine bar silver in New York in 1922 were as follows:

*Price of foreign silver per fine ounce in 1922, by months.*

| | | | |
|---|---|---|---|
| January | $0.65853 | August | $0.69819 |
| February | .65696 | September | .69888 |
| March | .64838 | October | .68405 |
| April | .67055 | November | .65485 |
| May | .71623 | December | .64250 |
| June | .71614 | | |
| July | .70693 | Average | .67934 |

Silver to be salable to the Director of the Mint under the Pittman Act and mint regulations must be of undoubted domestic production and reduction, and the benefit of the higher price must have been given to the owner of the producing mine.

*Price of domestic silver per fine ounce, 1865–1922.*[1]

| | | | | | |
|---|---|---|---|---|---|
| 1865 | $1.337 | 1886 | $0.99 | 1907 | $0.66 |
| 1866 | 1.339 | 1887 | .98 | 1908 | .53 |
| 1867 | 1.33 | 1888 | .94 | 1909 | .52 |
| 1868 | 1.326 | 1889 | .94 | 1910 | .54 |
| 1869 | 1.325 | 1890 | 1.05 | 1911 | .53 |
| 1870 | 1.328 | 1891 | .99 | 1912 | .615 |
| 1871 | 1.325 | 1892 | .87 | 1913 | .604 |
| 1872 | 1.322 | 1893 | .78 | 1914 | .553 |
| 1873 | 1.297 | 1894 | .63 | 1915 | .507 |
| 1874 | 1.278 | 1895 | .65 | 1916 | .658 |
| 1875 | 1.24 | 1896 | .68 | 1917 | .824 |
| 1876 | 1.16 | 1897 | .60 | 1918 | .980 |
| 1877 | 1.20 | 1898 | .59 | 1919 | 1.12 |
| 1878 | 1.15 | 1899 | .60 | 1920 | 1.09 |
| 1879 | 1.12 | 1900 | .62 | 1921 | 1.00 |
| 1880 | 1.15 | 1901 | .60 | 1922 | 1.00 |
| 1881 | 1.13 | 1902 | .53 | | |
| 1882 | 1.14 | 1903 | .54 | Average yearly price, period 1865–1922 | .9132 |
| 1883 | 1.11 | 1904 | .58 | | |
| 1884 | 1.11 | 1905 | .61 | | |
| 1885 | 1.07 | 1906 | .68 | | |

## PRODUCTION OF GOLD AND SILVER SINCE 1792.

*Gold and silver produced in the United States, 1792–1922.*

[The estimate for 1792–1872 is by R. W. Raymond, commissioner, and for the period since 1872 by the Director of the Mint.]

| Period. | Gold. | | Silver. | |
|---|---|---|---|---|
| | Fine ounces. | Value. | Fine ounces. | Commercial value. |
| 1792–1847 | 1,186,977 | $24,537,000 | 309,500 | $404,500 |
| 1848–1872 | 58,279,781 | 1,204,750,000 | 118,568,200 | 157,749,900 |
| 1873–1922 | 143,311,146 | 2,962,504,300 | 2,549,806,385 | 2,036,972,525 |
| | 202,777,904 | 4,191,791,300 | 2,668,684,085 | 2,195,126,925 |

Although the output of gold during the period 1792–1922 was less than one-thirteenth the output of silver in quantity, its value was nearly twice that of the silver.

The average commercial value per fine ounce of silver for the 130 years contributing to the total domestic production was $0.823. Fluctuations in value of silver per fine ounce are shown in the curve in Figure 16. For the years shown (1871 to 1922, inclusive), the average annual value was more than $0.80 before 1893 and has been less than that figure every year since, until 1917, when it was $0.82; 1918, when it was $0.98; 1919, when it was $1.12; 1920, when it was $1.09; and 1921 and 1922, when it was $1.

[1] Based on London price of bar silver 1.000 fine and taken at average price and par of exchange, 1865–1915; New York dealers' buying price for 1916–1919; average buying price of silver from domestic mines for 1920–1922.

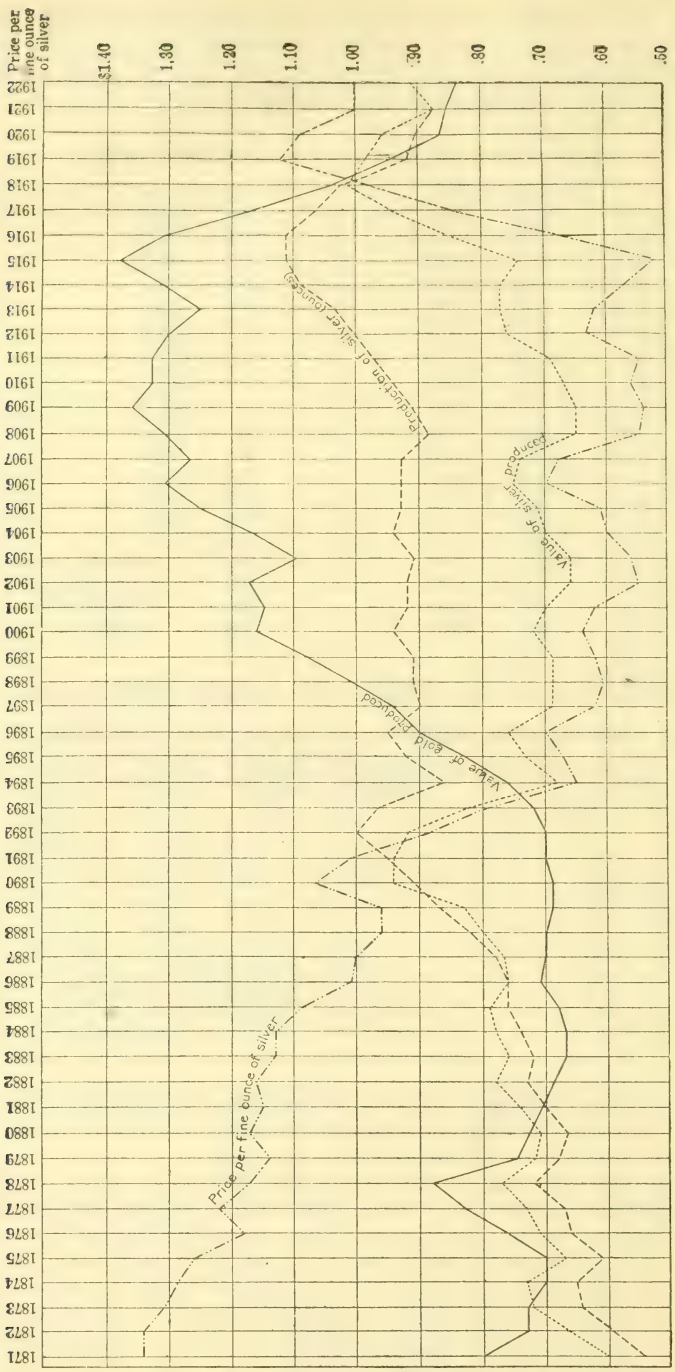



FIGURE 16.—Curves showing production and value of gold and silver and price per fine ounce of silver in the United States, 1871–1922.

## IMPORTS AND EXPORTS.

*Value of gold and silver imported into and exported from the United States, 1921 and 1922.*[a]

| | Imports. | Exports. | Excess of— | |
|---|---|---|---|---|
| | | | Imports. | Exports. |
| **1921.** | | | | |
| Gold: | | | | |
| Contained in domestic ore and base bullion | | $77,413 | | $77,413 |
| Contained in foreign ore and base bullion | $33,564,537 | 476 | $33,564,061 | |
| Domestic bullion refined | 459,413 | 1,612,349 | | 1,152,936 |
| Foreign bullion refined | 503,136,371 | 2,005,408 | 501,130,963 | |
| United States coin | 37,966,552 | 17,921,219 | 20,045,333 | |
| Foreign coin | 116,121,424 | 2,274,512 | 113,846,912 | |
| | 691,248,297 | 23,891,377 | 668,587,269 | 1,230,349 |
| Excess imports over exports | | | 667,356,920 | |
| Silver: | | | | |
| Contained in domestic ore and base bullion | | 13,851 | | 13,851 |
| Contained in foreign ore and base bullion | 46,640,993 | 2,260 | 46,638,733 | |
| Domestic bullion refined | | 23,625,091 | | 23,625,091 |
| Foreign bullion refined | 7,575,122 | 21,077,634 | | 13,502,512 |
| United States coin | 2,891,952 | 864,005 | 2,027,947 | |
| Foreign coin | 6,134,604 | 5,992,558 | 142,046 | |
| | 63,242,671 | 51,575,399 | 48,808,726 | 37,141,454 |
| Excess imports over exports | | | 11,667,272 | |
| **1922.** | | | | |
| Gold: | | | | |
| Contained in domestic ore and base bullion | | 73,709 | | 73,709 |
| Contained in foreign ore and base bullion | 24,275,253 | | 24,275,253 | |
| Domestic bullion refined | 1,328,408 | 5,468,225 | | 4,139,817 |
| Foreign bullion refined | 180,365,162 | 81,799 | 180,283,363 | |
| United States coin | 4,868,558 | 30,323,172 | | 25,454,614 |
| Foreign coin | 64,332,404 | 927,989 | 63,404,415 | |
| | 275,169,785 | 36,874,894 | 267,963,031 | 29,668,140 |
| Excess imports over exports | | | 238,294,891 | |
| Silver: | | | | |
| Contained in domestic ore and base bullion | | 17,237 | | 17,237 |
| Contained in foreign ore and base bullion | 57,034,500 | | 57,034,500 | |
| Domestic bullion refined | | 25,060,886 | | 25,060,886 |
| Foreign bullion refined | 11,120,413 | 31,720,047 | | 20,599,634 |
| United States coin | 1,249,247 | 379,792 | 869,455 | |
| Foreign coin | 1,402,493 | 5,629,324 | | 4,226,831 |
| | 70,806,653 | 62,807,286 | 57,903,955 | 49,904,588 |
| Excess imports over exports | | | 7,999,367 | |

[a] According to Bureau of Foreign and Domestic Commerce, Department of Commerce.

## DOMESTIC SUPPLY.

The remarkable gain in the domestic supply of gold indicated by the great excess of $530,200,000 in imports over exports in 1916, of $180,000,000 in 1917, and of $21,000,000 in 1918 had come to a halt in the early part of 1919 but was resumed in 1920, owing to large imports of foreign bullion and coin, and continued in 1921 and 1922.

The value of the exports of silver in 1922 was approximately $11,232,000 more than in 1921.

The total number of silver dollars remelted under the Pittman Act was 270,232,722, which, if all had been of exact legal weight, would have contained 209,009,120.9 fine ounces of silver but which actually yielded on remelting 208,622,056.8 fine ounces. The purchases of silver from domestic mines in 1922 at the price fixed under the Pittman Act amounted to 62,181,024 fine ounces. The purchases in 1922 by months were as follows, in fine ounces: January, 2,532,000;

February, 3,444,740; March, 5,370,980; April, 8,117,748; May, 4,122,400; June, 5,204,750; July, 2,841,000; August, 8,325,000; September, 4,377,445; October, 7,105,625; November, 3,242,836; December, 7,496,500. The total purchases under the Pittman Act to December 31, 1922, were 150,750,912 fine ounces. The purchases in 1923 were as follows, in fine ounces: January, 4,622,000; February, 6,768,762; March, 16,215,394; April, 4,570,516; May, 16,160,698, June, 1,496, 753. The total purchases to June 30, 1923, have been 200,585,035 fine ounces.

Resumption of mining at base-metal mines increased the quantity of domestic silver, and in June, 1923, according to the Treasury Department, the total purchases reached the quantity of silver necessary under the Pittman Act to replace the silver dollars remelted.

The domestic supply of new gold comes chiefly from dry and siliceous gold ores, treated mainly in gold mills by amalgamation and cyanidation or both and partly by smelting, and from placer gravels worked largely by dredges. As shown on page 620, these ores and placer gravels supplied more than 91 per cent of the yield of gold in 1922. Considerable gold is usually recovered also from the refining of copper bullion from copper ores, especially in the West Mountain or Bingham district, Utah, and the Summit Valley or Butte district, Mont.

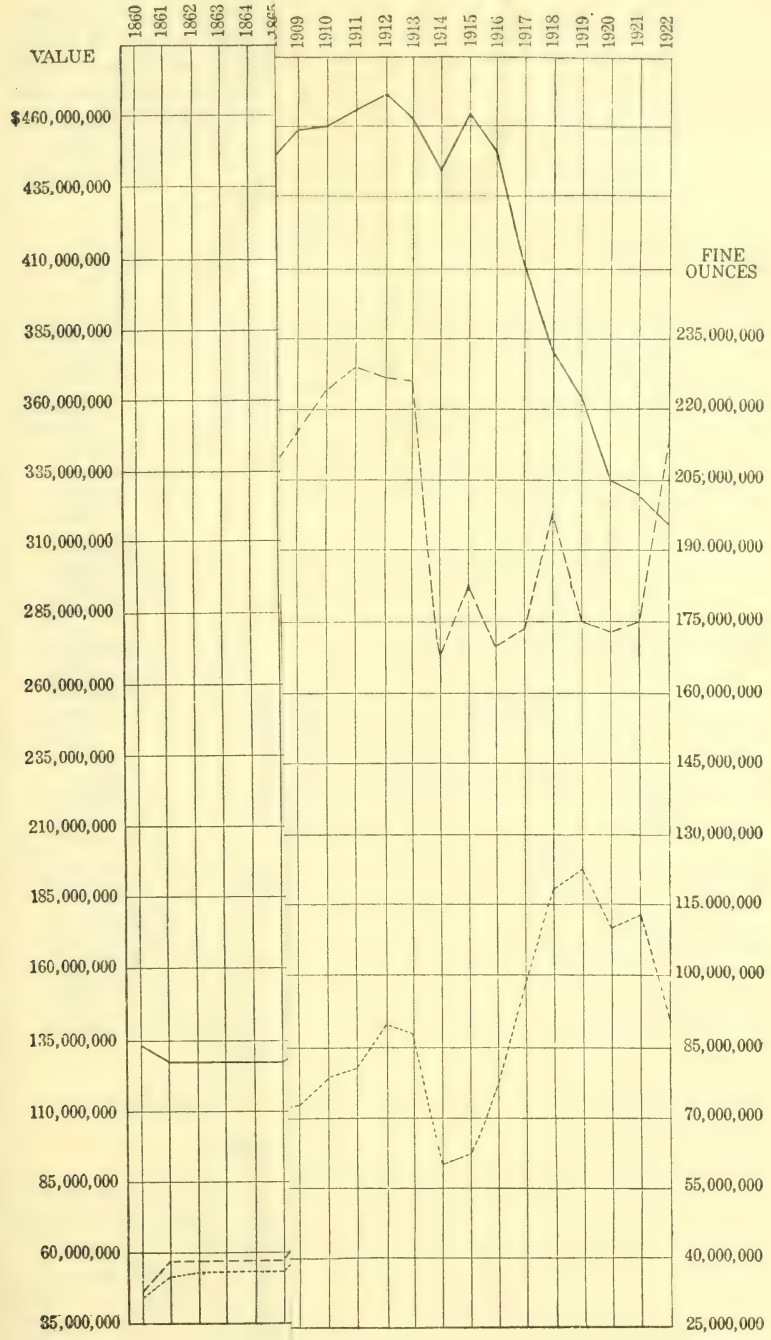
In 1922 the copper ores of the United States produced 5.71 per cent of the total gold, against only 2.25 per cent in 1921. The natural tendency has been for the proportionate output from gold ores to decrease with declining yield from some of the principal gold camps and for that from copper ores to increase, with a general net decline of total yield of gold owing to the preponderant output from gold and gold-silver ores.

The principal domestic supply of new silver came from dry and siliceous silver and silver-gold ores, copper ores, lead ores, and lead-zinc ores in the proportion of 46.78, 16.95, 27.38, and 4.96 per cent, respectively, in 1922, against 52.05, 10.32, 32.19, and 4.28 per cent, respectively, in 1921. The greater part of the dry and siliceous silver ores is milled and cyanided at or near the mines, but a small quantity of richer ore is shipped to copper and lead smelters.

## WORLD'S PRODUCTION OF GOLD.

The estimated value of the gold produced in the world from 1860 to 1922, inclusive, was $14,324,716,600. In 1922 the estimated production of gold in the world decreased $10,802,600, after a decrease of about $6,740,500 in 1921, of $28,769,000 in 1920, of $15,136,000 in 1919, and of $38,500,000 in 1918. The production in the United States decreased $1,218,200 and Africa $21,585,700. The large decrease in the Rand mines in South Africa was due to labor troubles in the first three months of 1922. There were fair increases in Canada, Mexico, and some South American countries.

The prevailing tendency during recent years toward a declining world output of new gold caused by the high cost of labor and supplies, which made the operation of many gold mines unprofitable, has been modified to some extent by greater political and financial stability in some countries, which will tend to increased operations or the reopening of old properties. This will temporarily result in relatively small increases over the abnormally low output of gold


1860
1861
1862
1863
1864
1865
1909
1910
1911
1912
1913
1914
1915
1916
1917
1918
1919
1920
1921
1922
VALUE
$460,000,000
435,000,000
410,000,000
385,000,000
360,000,000
335,000,000
310,000,000
285,000,000
260,000,000
235,000,000
210,000,000
185,000,000
160,000,000
135,000,000
110,000,000
85,000,000
60,000,000
35,000,000
FINE OUNCES
235,000,000
220,000,000
205,000,000
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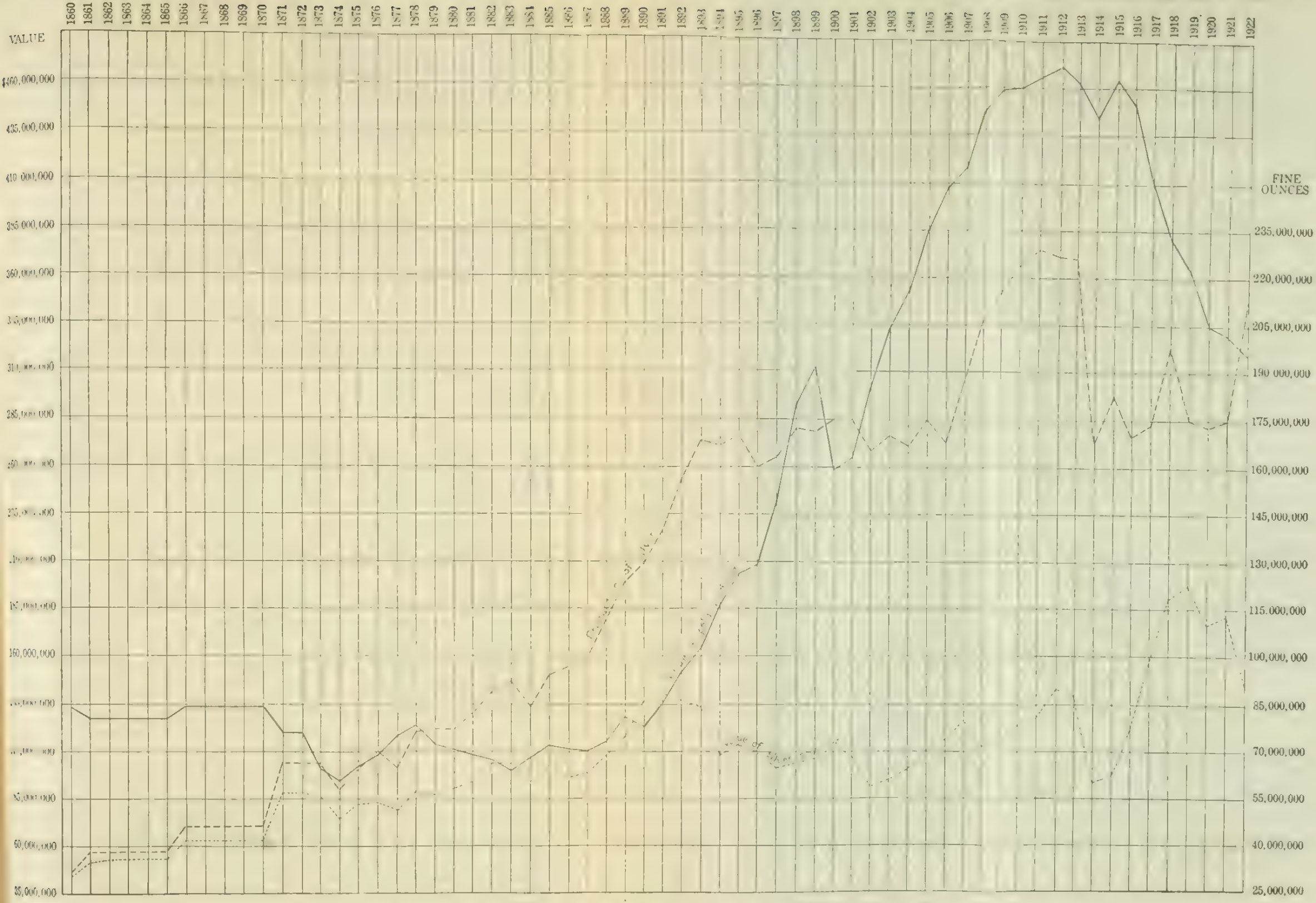


CURVES SHOWING PRODUCTION AND VALUE OF GOLD AND SILVER IN THE WORLD, 1860-1922.

from these countries in the last four or five years. In 1923 there will probably be moderate increases in Canada, Mexico, Peru, and a few other countries and a large increase in South Africa, due entirely to the continuous operation of mines on the Rand and not to any radical improvement in general unfavorable mining conditions. In the following table is shown the output of gold by countries, as given by the Bureau of the Mint, with slight changes resulting from late information.

*World's production of gold, 1917–1922.*

| Country. | 1917 | 1918 | 1919 | 1920 | 1921 | 1922 |
|---|---|---|---|---|---|---|
| North America: | | | | | | |
| United States | $83,750,700 | $68,646,700 | $60,333,400 | $51,186,900 | $50,067,300 | $48,849,100 |
| Canada | 15,273,000 | 14,687,900 | 15,850,400 | 15,853,500 | 19,148,900 | 26,116,100 |
| Mexico | 9,000,000 | 16,824,700 | 15,676,500 | 15,265,900 | 14,152,600 | 15,468,500 |
| Central America | 3,122,000 | 3,400,000 | 3,300,000 | 3,000,000 | 2,500,000 | 2,500,000 |
| Africa | 214,304,300 | 197,073,600 | 193,896,500 | 191,339,800 | 186,968,400 | 165,382,700 |
| Australasia | 34,398,100 | 29,268,600 | 26,911,500 | 22,651,700 | 18,672,700 | 18,819,300 |
| Europe: | | | | | | |
| Russia, Finland, and Siberia | 18,000,000 | 12,000,000 | 11,000,000 | 1,182,900 | 892,600 | 3,028,600 |
| Austria-Hungary | 150,000 | 180,000 | ..... | ..... | 3,300 | 11,300 |
| Sweden | 10,000 | 10,000 | 10,000 | 4,700 | 1,300 | 700 |
| Italy | 700 | 22,800 | 15,300 | 15,000 | ..... | ..... |
| France | 700,000 | 500,000 | 151,000 | ..... | 49,100 | 300,000 |
| Germany | ..... | ..... | ..... | 91,700 | 86,400 | 112,300 |
| Yugoslavia | ..... | ..... | ..... | 66,500 | 82,400 | 143,500 |
| Great Britain | 5,000 | ..... | ..... | 700 | ..... | ..... |
| Greece | ..... | ..... | 4,600 | 10,600 | ..... | ..... |
| Czechoslovakia | ..... | ..... | 125,600 | 181,100 | 235,900 | 199,400 |
| Rumania | ..... | ..... | ..... | ..... | 856,000 | 888,600 |
| Spain | ..... | ..... | ..... | ..... | ..... | 18,700 |
| South America: | | | | | | |
| Argentina | 4,600 | 4,000 | 4,000 | 100,000 | 75,000 | 75,000 |
| Bolivia and Chile | 770,700 | 770,000 | 770,000 | 905,000 | 939,100 | 1,981,200 |
| Colombia | 5,000,000 | 4,866,500 | 6,000,000 | 5,800,000 | 6,000,000 | 6,000,000 |
| Ecuador | 887,800 | 800,000 | 800,000 | 750,000 | 749,500 | 749,600 |
| Brazil | 2,958,000 | 2,800,000 | 2,000,000 | 2,600,000 | 2,780,000 | 3,031,900 |
| Venezuela | 636,900 | 473,200 | 600,000 | 389,400 | 625,400 | 358,900 |
| Guiana— | | | | | | |
| British | 519,000 | 400,000 | 335,200 | 200,000 | 265,200 | 224,800 |
| Dutch | 445,000 | 322,200 | 329,300 | 258,500 | 233,300 | 248,500 |
| French | 1,438,500 | 1,100,000 | 1,100,000 | 900,000 | 1,000,000 | 1,000,000 |
| Peru | 1,254,100 | 1,250,000 | 1,348,400 | 1,297,300 | 1,599,700 | 1,683,400 |
| Uruguay | 10,000 | 10,000 | 10,000 | 400 | 7,000 | 7,000 |
| Asia: | | | | | | |
| Japan | 4,679,700 | 5,105,900 | 4,824,900 | 5,130,400 | 4,901,400 | 4,833,200 |
| China | 3,600,100 | 3,600,000 | 3,300,000 | 2,584,000 | 2,067,200 | 2,067,200 |
| Indo-China | 50,000 | 50,000 | 40,000 | 3,300 | 3,300 | 3,300 |
| Chosen (Korea) | 3,363,800 | 3,300,000 | 2,800,000 | 1,571,100 | 2,705,800 | 2,643,700 |
| India British | 10,812,800 | 10,028,000 | 10,486,000 | 10,316,700 | 8,945,200 | 9,054,600 |
| East Indies, British and Dutch | 2,853,700 | 2,571,400 | 2,564,000 | 2,479,500 | 2,446,600 | 2,756,000 |
| Federated Malay States | 342,400 | 345,300 | 339,000 | 265,700 | 276,700 | 310,200 |
| Taiwan (Formosa) | 1,081,200 | 513,700 | 417,200 | 279,000 | 588,200 | 586,200 |
| Sarawak | ..... | ..... | 446,000 | 338,000 | 353,300 | 22,700 |
| | 419,422,100 | 380,924,500 | 365,788,800 | 337,019,300 | [a]330,278,800 | [b]319,476,200 |

[a] Revised figures. [b] Revised figures will be given in the report for 1923.

## WORLD'S PRODUCTION OF SILVER.

The figures for the world's production of silver in 1922 show that the United States and Canada produced 35 per cent, against 39 per cent in 1921, and that Mexico, Central America, and South America produced nearly 50 per cent, so that approximately only 32,730,000 ounces of silver came from all other countries, mainly from Australia, Burma, Japan, and Spain. There were increases of about 3,187,600 ounces in the United States, 16,611,500 ounces in Mexico, 4,170,900 ounces in Bolivia and Chile, 5,446,500 ounces in Canada, 3,161,200

ounces in Peru, and 6,331,000 ounces in Australasia. The total increase in the world's production was about 42,256,000 ounces. There will probably be a considerable increase in the world's production of silver in 1923, owing to greatly increased activity at copper mines in the United States, Peru, and Chile and at lead and zinc mines in Burma, Mexico, Australia, and Spain. As the silver from domestic mines was, until June, 1923, purchased by the United States Mint, all the silver consumed in the arts and industries to that date was obtained from foreign sources. After June, 1923, producers of domestic silver had to sell in the open market at a price which was 36 to 38 cents an ounce lower than that paid under the Pittman Act. The open-market price has been fairly stable and as high as was expected under existing conditions, although the lower price has resulted in closing a number of mines in the United States from which siliceous ores containing a little silver were being mined. The value of the silver produced in the world in 1922, at $0.67934 a fine ounce, was about $145,067,000, and the total value from 1860 to 1922, inclusive, was $6,230,326,000.

Most of the world's output of silver is produced or refined in the United States, but a large part of it is consumed in Great Britain, India, and China, and the price of silver has been dominated by the London market. "Silver, its romance and history," by Benjamin White, contains information relating to the buying and selling of silver and the fixing of market quotations, which was quoted in the chapter on gold and silver in Mineral Resources for 1918. A study of the effects of the World War on the movement and markets for silver is given by André Pailhas.[2]

*World's production of silver, 1917–1922, in fine ounces.*

| Country. | 1917 | 1918 | 1919 | 1920 | 1921 | 1922 |
|---|---|---|---|---|---|---|
| North America: | | | | | | |
| United States | 71,740,400 | 67,810,100 | 56,682,400 | 55,361,600 | 53,052,400 | 56,240,100 |
| Canada | 22,221,300 | 21,284,600 | 16,020,700 | 12,793,500 | 13,134,900 | 18,581,400 |
| Mexico | 35,000,000 | 62,517,000 | 65,904,200 | 66,662,200 | 64,465,400 | 81,076,900 |
| Central America | 2,369,500 | 2,900,000 | 2,800,000 | 2,700,000 | 2,000,000 | 2,000,000 |
| South America: | | | | | | |
| Bolivia and Chile | 4,151,600 | 4,335,000 | 4,335,000 | 4,804,400 | 4,958,900 | 9,129,800 |
| Argentina | 29,000 | 25,000 | 25,000 | 30,000 | 25,000 | 25,000 |
| Brazil | 25,000 | 25,000 | 25,000 | 30,000 | 33,000 | ..... |
| Colombia | 325,000 | 325,000 | 494,300 | 480,000 | 500,000 | 500,000 |
| Ecuador | 45,000 | 40,000 | 40,000 | 35,000 | 75,000 | 75,000 |
| Peru | 10,864,400 | 10,800,000 | 9,821,700 | 9,196,300 | 10,008,600 | 13,169,800 |
| Guiana and Uruguay | 8,000 | 8,000 | 8,000 | 8,500 | 11,000 | 11,000 |
| Venezuela | 3,300 | 3,000 | 4,100 | 3,500 | 2,700 | 2,700 |
| Europe: | | | | | | |
| Czechoslovakia | ..... | ..... | 596,400 | 694,100 | 703,100 | 900,200 |
| Austria | 1,500,000 | 1,750,000 | | | 10,500 | 8,600 |
| France | ..... | ..... | 12,000 | 321,500 | 321,500 | 321,500 |
| Germany | ..... | ..... | ..... | 3,305,000 | 3,387,400 | 5,372,600 |
| Yugoslavia (Serbia) | ..... | ..... | ..... | 15,000 | 15,900 | 26,800 |
| Great Britain | 75,000 | 50,000 | 68,400 | 76,400 | 11,300 | 27,600 |
| Greece | 350,000 | 350,000 | 160,000 | 220,900 | ..... | ..... |
| Italy | 486,500 | 500,000 | 350,000 | 297,500 | 199,300 | 385,800 |
| Norway | 294,900 | 270,200 | 312,800 | 323,200 | 196,100 | 194,800 |
| Spain and Portugal | 2,850,000 | 3,100,000 | 1,548,200 | 2,956,500 | 2,679,400 | 2,778,200 |
| Russia | 500,000 | 400,000 | 400,000 | 50,000 | 40,000 | 150,000 |
| Serbia | 20,000 | 20,000 | 20,000 | ..... | ..... | ..... |
| Sweden | 35,000 | 31,500 | 31,500 | 11,600 | 13,300 | 100 |
| Turkey | 400,000 | 400,000 | 100,000 | 100,000 | 100,000 | 125,000 |
| Roumania | ..... | ..... | ..... | ..... | 96,500 | 109,200 |
| Australasia | 10,000,000 | 10,000,000 | 7,188,000 | 2,684,900 | 5,362,200 | 11,693,200 |

[2] Silver for 1914–1920, Paris, Librairie générale de droit et de jurisprudence, 1922.

*World's production of silver, 1917–1922, in fine ounces*—Continued.

| Country. | 1917 | 1918 | 1919 | 1920 | 1921 | 1922 |
|---|---|---|---|---|---|---|
| Asia: | | | | | | |
| British India | 275,000 | 270,000 | 190,600 | 170,600 | 150,000 | 150,000 |
| China | 63,900 | 70,000 | 65,000 | 50,000 | 40,000 | 40,000 |
| Chosen (Korea) | 26,500 | 26,000 | 20,000 | 1,200 | 3,000 | 10,800 |
| Dutch East Indies | 400,000 | 400,000 | 1,006,800 | 1,027,900 | 1,022,000 | 1,109,600 |
| Indo-China | 1,000 | 1,000 | 1,000 | | | |
| Taiwan (Formosa) | 39,600 | 26,900 | 25,000 | 20,000 | 26,500 | 25,000 |
| Japan | 7,111,700 | 6,600,400 | 4,950,500 | 4,892,400 | 4,187,700 | 3,886,300 |
| Burma | 1,793,700 | 1,970,500 | 1,975,000 | 2,700,000 | 3,437,600 | 4,094,300 |
| Sarawak | | | 6,300 | 5,200 | 3,400 | 500 |
| Africa: | | | | | | |
| Algeria | | | 170,800 | 150,000 | | |
| Belgian Congo | 10,300 | 10,500 | 10,000 | 10,700 | 5,800 | 6,500 |
| Egypt | 900 | 800 | 300 | 300 | | |
| French East Africa | 20,000 | 20,000 | 17,700 | 13,800 | 12,900 | 12,900 |
| Madagascar | | | | | | |
| Rhodesia | 212,000 | 175,700 | 180,600 | 164,900 | 161,900 | 184,400 |
| Transvaal, Cape Colony, Natal | 938,100 | 877,500 | 891,300 | 891,300 | 830,800 | 1,115,700 |
| Portuguese East Africa | 1,200 | 1,200 | 1,000 | 700 | 500 | 500 |
| | 174,187,800 | 197,394,900 | 176,459,600 | 173,260,600 | [a]171,285,500 | [b]213,541,800 |

[a] Revised figures. [b] Revised figures will be given in the report for 1923.

In 1923 the United States Senate appointed a commission to investigate and report to Congress by January 1, 1924, on (1) the causes of the continuing decrease in the production of gold and silver, (2) the causes of the depressed condition of the gold and silver industry in the United States, (3) the production, reduction, refining, transportation, marketing, sales, and uses of gold and silver in the United States and elsewhere, and (4) the effect of the decreased production of gold and silver on commerce, industry, exchange, and prices. The members of this commission are Senators Oddie and Pittman, of Nevada; Senator Walsh, of Montana; Senator Gooding, of Idaho; and Senator Sterling, of South Dakota. H. N. Lawrie is assistant to the commission, and C. E. Alden is secretary. The members of the commission and the owners of mines protested vigorously against the ruling of the Secretary of the Treasury regarding allocations of silver to the mint for subsidiary coinage. The ruling reduced the quantity of silver purchased under the Pittman Act about 10,000,000 ounces. The commission also promptly took action to collect all available data on the subjects assigned, and the assistant to the commission prepared a summary entitled "Gold and silver statistics," which contains tables and charts derived from the United States Geological Survey, Bureau of the Mint, Department of Commerce, and other sources.

The financial and investment division of the Department of Commerce, at the request of the commission, has issued a report (Bulletin 140) entitled "Changes in the monetary uses of silver since 1914," by Leland Rex Robinson, containing data obtained through the American consular service. An analysis of the information received is given as follows:

The use of silver for reserve purposes has declined since 1914 in most countries, both absolutely and in proportion to gold and other forms of cover for issues of notes; numerous facts have operated to reduce the relative importance of silver as a circulating medium, in many countries there has been a reduction in the fineness or content of silver coins, and no movement appears to be in progress that would justify an assumption that silver will soon regain its pre-war relative position as reserve for issues of notes or as a circulating medium.

A meeting was held in Reno, Nev., September 4, 5, and 6, 1923, which was attended by representatives of nearly all the large producers and marketers of silver in the United States, Mexico, and Canada. The meeting was harmonious, and no effort was made to minimize the difficulties of the silver situation, nor was any hostility shown to existing methods of fixing the price of silver, and there was no discussion or thought of departing from the gold monetary standard. The sole object of the meeting was to devise ways and means of helping the mining industry to obtain a reasonable profit in mining gold and silver. Under a resolution adopted at this meeting W. Mont Ferry, the chairman, has appointed a committee composed of C. F. Kelley, Charles Bocking, F. H. Brownell, Fred Carroll, Stanley A. Easton, John Hays Hammond, Alfred Harrell, C. A. Holder, J. G. Kirchen, E. J. Raddatz, F. Y. Robertson, and Robert E. Talley, to whom is delegated the task of formulating a plan for the organization of an association under the Webb-Pomerene Act. Three more members of the committee are to be selected from Canadian and Mexican mine operators. The plan of this committee will be submitted to a permanent Pan American silver conference, which is to be formed according to methods approved by another committee, of which Alfred Harrell, of San Francisco, is chairman.

## MINE REPORT.

### METHOD OF COLLECTING STATISTICS.

The first table in this report presents the final official figures of the production of gold and silver in the United States in 1922 as agreed upon by the Bureau of the Mint and the United States Geological Survey. With the comparatively unimportant exceptions of domestic gold and silver contained in ores and mattes exported for reduction during the year, these figures record the actual production of gold and silver bullion from domestic ores in marketable form as metals, either refined or unrefined.

Owing to the difficulty of tracing this total gold and silver produced back to its source by States, counties, and mining districts, however, the Geological Survey attacks this problem of distribution by systematic investigation of the "mine production" of ores containing gold and silver during the calendar year and of the output of the placer mines. In this way the state of the mining industry is studied in detail, and the output is classified by methods of production and by kinds of ore, as well as by mining districts. The resulting figures form the basis of the mine reports.

Of the two plans for ascertaining the gold and silver production of the United States one is a measure of the mining industry and the other a measure of the metallurgic industry; one reports the mine output and its recoverable content and the other the metal actually recovered in marketable form. The two methods will not produce exactly corresponding results, but the figures for a period of years sufficiently long to compensate for overlap or lag should agree within allowable limits of error due to the complexity of the problem involved.

*Mine production of gold and silver in the United States in 1922.*

| State. | Gold. | | Silver (fine ounces and dollars). | Increase or decrease. | |
|---|---|---|---|---|---|
| | Fine ounces. | Value. | | Gold. | Silver (fine ounces). |
| Alaska | 359,057.00 | $7,422,367 | 729,945 | −$651,173 | −31,140 |
| Arizona | 170,479.98 | 3,524,134 | 4,531,864 | +593,831 | +2,062,470 |
| California | 709,677.99 | 14,670,346 | 3,100,065 | −1,034,476 | −529,158 |
| Colorado | 308,314.15 | 6,373,419 | 5,855,911 | −461,909 | +224,254 |
| Georgia | 155.96 | 3,224 | 364 | +2,202 | +360 |
| Idaho | 24,255.46 | 501,405 | 6,081,865 | −44,326 | +1,337 |
| Illinois | | | 6,025 | | +4,680 |
| Michigan | | | 376,990 | | +66,263 |
| Missouri | | | 212,656 | | +142,754 |
| Montana | 80,145.62 | 1,656,757 | 12,468,151 | +175,994 | +5,909,438 |
| Nevada | 159,510.95 | 3,297,384 | 8,619,587 | −15,373 | +1,535,805 |
| New Mexico | 19,964.02 | 412,693 | 752,240 | +215,871 | +180,341 |
| North Carolina | 93.80 | 1,939 | 9 | −1,240 | −9 |
| Oregon | 25,714.60 | 531,568 | 151,812 | −350,466 | +109,692 |
| Pennsylvania | 125.78 | 2,600 | 2,215 | +2,600 | +2,215 |
| Philippine Islands | 73,839.60 | 1,526,400 | 27,994 | +213,304 | +1,803 |
| South Carolina | 1.55 | 32 | | −18 | |
| South Dakota | 315,297.99 | 6,517,788 | 118,760 | −87,379 | +6,296 |
| Tennessee | 208.98 | 4,320 | 78,341 | −600 | −20,421 |
| Texas | | | 644,980 | | +128,214 |
| Utah | 111,110.36 | 2,296,855 | 17,271,100 | +526,950 | +5,019,102 |
| Virginia | 34.15 | 706 | 6 | −57 | −2 |
| Washington | 9,044.43 | 186,965 | 205,046 | +58,479 | +62,596 |
| Wyoming | 58.39 | 1,207 | 57 | +1,145 | −54 |
| | 2,367,090.76 | 48,932,109 | 61,235,983 | −856,641 | +14,876,836 |

*Gold and silver produced in the United States, 1905–1922, according to mint and to mine returns.*

| Year. | Mint. | | Mine. | |
|---|---|---|---|---|
| | Gold. | Silver. | Gold. | Silver. |
| | | *Ounces.* | | *Ounces.* |
| 1905–1915 | $1,038,286,100 | 671,818,275 | $1,031,369,692 | 672,280,562 |
| 1916 | 92,590,300 | 74,414,802 | 92,822,430 | 78,875,176 |
| 1917 | 83,750,700 | 71,740,362 | 82,032,745 | 70,665,531 |
| 1918 | 68,646,700 | 67,810,139 | 67,701,936 | 68,063,090 |
| 1919 | 60,333,400 | 56,682,445 | 58,225,112 | 51,907,869 |
| 1920 | 51,186,900 | 55,361,573 | 50,537,281 | 56,559,022 |
| 1921 | 50,067,300 | 53,052,441 | 49,788,750 | [a] 46,359,147 |
| 1922 | 48,849,100 | 56,240,048 | 48,932,109 | 61,235,983 |
| | 1,493,710,500 | 1,107,120,085 | 1,481,410,055 | 1,105,946,380 |

[a] Revised figures.

These figures show, according to the reports of the mint, a total excess of gold for the 18 years of $12,300,445, or a difference of less about 0.8 per cent, and a total excess of silver of 1,173,705 ounces, or a difference of about 0.1 per cent. The figures for Alaska placers are not considered to be so closely approximate as the total figures for gold, hence the differences for the United States proper are probably even lower. It is thought that those small differences are fully accounted for in the detailed discussions of the subject in previous reports of this series. For any one year an excess of mining over smelting and refining is indicated by larger returns in the mine reports for gold or silver, or both, and an excess of smelting and refining and drawing upon stocks is indicated by larger returns in the report of the mint.

## UNITS OF MEASUREMENT.

In the measurement of ores and concentrates the short ton of 2,000 pounds is used throughout. The price of gold is fixed by law at $20.67+ per fine ounce. The annual average prices for silver from 1865 to 1922 are given on page 597.

## PRODUCTION OF GOLD AND SILVER REPORTED FROM THE MINES.

The preceding table gives the quantity and value of the output of recoverable gold and silver ("mine production") by States reported from the producing mines in 1922 to the United States Geological Survey. The increase or decrease of production shows results by comparison with the corresponding Geological Survey mine figures for 1921.

The decrease of $856,641 in the mine production of gold in 1922 followed a decrease of $748,531 in 1921, of $7,687,831 in 1920, of $9,476,824 in 1919, of $14,330,809 in 1918, and of $10,789,685 in 1917. The increase of 14,876,836 ounces in silver followed a decrease of 10,199,875 ounces in 1921.

The principal gold-producing States in 1922 were California, Alaska, South Dakota, Colorado, Arizona, and Nevada, and these six States together made more than 85 per cent of the total output. The only notable increases in gold were in Arizona, Utah, New Mexico, the Philippine Islands, Montana, and Washington. The most notable decreases in gold were in California, Alaska, Colorado, and Oregon.

The principal silver-producing States in 1922 were Utah, Montana, Nevada, Idaho, Colorado, and Arizona, and these six States together produced nearly 90 per cent of the total for the United States. The only comparatively large decrease in 1922 was in California. There were large increases in Montana, Utah, Arizona, Nevada, Colorado, and New Mexico.

About $27,336,500 in gold, or 56 per cent of the entire output in the United States in 1922, was produced by 25 companies, none of which produced less than $350,000. The largest producer was the celebrated Homestake mine, in South Dakota. Nineteen of the larger properties produced gold from dry and siliceous ores, three produced it from gravels by dredging, two from copper ores, and one recovered gold in the treatment of lead and lead-zinc ores. Ten of the largest producers of gold in 1922 were in California, four in Colorado, three each in Alaska, Utah, and Arizona, and one each in Nevada and South Dakota.

*Larger producers of gold in the United States in 1922, in order of output.*

| Rank. | Operator. | State. | Mining district. | Source of gold. |
|---|---|---|---|---|
| 1 | Homestake Mining Co. | South Dakota | Whitewood | Dry and siliceous ores. |
| 2 | Yuba Consolidated Goldfields | California | Marysville | Dredging gravels. |
| 3 | Cresson Consolidated Mining Co. | Colorado | Cripple Creek | Dry and siliceous ores. |
| 4 | Natomas Co. of California | California | Oroville and Folsom. | Dredging gravels. |
| 5 | United Eastern Mining Co. | Arizona | Oatman | Dry and siliceous ores. |
| 6 | Empire Mines | California | Grass Valley | Do. |
| 7 | Alaska Juneau Mining Co. | Alaska | Juneau | Do. |
| 8 | Original 16 to 1 Mine | California | Allegheny | Do. |
| 9 | North Star Mines | do | Grass Valley | Do. |
| 10 | Carson Hill Gold Mines | do | Mother Lode | Do. |
| 11 | Chichagoff Mining Co. | Alaska | Sitka | Do. |
| 12 | Portland Gold Mining Co. | Colorado | Cripple Creek | Do. |
| 13 | Tomboy Gold Mines Co. | do | Upper San Miguel. | Do. |
| 14 | Argonaut Gold Mining Co. | California | Mother Lode | Do. |
| 15 | Utah Copper Co. | Utah | West Mountain | Copper ore. |
| 16 | Kennedy Mining Co. | California | Jackson | Dry and siliceous ores. |
| 17 | Elkoro Mines Co. | Nevada | Jarbidge | Do. |
| 18 | Plymouth Consolidated Mining Co. | California | Mother Lode | Do. |
| 19 | Kuskokwim Dredge Co. | Alaska | McKinley | Dredging gravels. |
| 20 | Calumet & Arizona Mining Co. | Arizona | Warren | Copper ores. |
| 21 | Tightner Mining Co. | California | Allegheny | Dry and siliceous ores |
| 22 | Deer Trail Mining Co. | Utah | Mount Baldy | Do. |
| 23 | United States Mining Co. | do | West Mountain | Lead and lead-zinc ores. |
| 24 | Tom Reed Gold Mining Co. | Arizona | Oatman | Dry and siliceous ores. |
| 25 | Smuggler Union Mining Co. | Colorado | Upper San Miguel. | Do. |

Exclusive of the output of gold by the large producing operators $21,595,600 came from the operation of about 3,500 placer and deep mines, many of which produced between $100,000 and $300,000 each. Hundreds of mines, especially placer properties in California, Oregon, Idaho, Alaska, Arizona, and the Appalachian States, produced very small quantities of gold, and the average output of the smaller mines was $6,000.

The largest output of silver was that of the mines operated by the Anaconda Copper Mining Co., followed closely by the Chief Consolidated Mining Co. Of the mines enumerated in the subjoined list, five recovered silver from copper ore, six from lead ore, eight from dry and siliceous ores, three from lead ores and siliceous ores, one from zinc ore, one from pyritic ore, and one from lead-zinc ores. The California Rand mine, in California, and the Presidio mine, in Texas, were the largest producers of silver from ore that contained no appreciable quantity of any other metal. The output of the 25 properties was 37,037,100 ounces, or 60 per cent of the total production of silver in the United States in 1922. Seven of the largest producers were in Utah, four in Montana, four in Nevada, three in Arizona, three in Idaho, two in Colorado, and one each in California and Texas.

*Larger producers of silver in the United States in 1922, in order of output.*

| Rank. | Operator. | State. | Mining district. | Source of silver. |
|---|---|---|---|---|
| 1 | Anaconda Copper Mining Co. | Montana | Summit Valley (Butte). | Copper ores. |
| 2 | Chief Consolidated Mining Co. | Utah | Tintic | Lead and siliceous ores. |
| 3 | California Rand Silver (Inc.) | California | Randsburg | Dry and siliceous ores. |
| 4 | Park Utah Mining Co. | Utah | Blue Ledge | Siliceous and lead ores. |
| 5 | Tintic Standard Mining Co. | do | Tintic | Lead and siliceous ores. |
| 6 | Smuggler Union Mining Co. | Colorado | Upper San Miguel and Sneffels. | Siliceous ores. |
| 7 | Tonopah Extension Mining Co. | Nevada | Tonopah | Dry and siliceous ores. |
| 8 | West End Consolidated Mining Co. | do | do | Do. |
| 9 | Federal Mining & Smelting Co. | Idaho | Hunter and Warm Springs. | Lead ores. |
| 10 | Butte & Superior Mining Co. | Montana | Summit Valley | Zinc ores. |
| 11 | Bunker Hill & Sullivan Mining Co. | Idaho | Yreka | Lead ores. |
| 12 | Tonopah-Belmont Development Co. | Nevada | Tonopah | Dry and siliceous ores. |
| 13 | Hecla Mining Co. | Idaho | Leland | Lead ores. |
| 14 | Phelps Dodge Corporation | Arizona | Warren | Copper ores. |
| 15 | Elm Orlu Mining Co. | Montana | Summit Valley (Butte). | Lead-zinc ores. |
| 16 | Silver King Coalition Mining Co. | Utah | Uintah | Lead ores. |
| 17 | Vipont Silver Mining Co. | do | Ashbrook | Dry and siliceous ores. |
| 18 | Davis-Daly Copper Co. | Montana | Summit Valley (Butte). | Copper ores. |
| 19 | Ontario Silver Mining Co. | Utah | Uintah | Lead ores. |
| 20 | Tonopah Mining Co. | Nevada | Tonopah | Dry and siliceous ores. |
| 21 | Park City Mining & Smelting Co. | Utah | Snake Creek | Lead ores. |
| 22 | Calumet & Arizona Mining Co. | Arizona | Warren | Copper ores. |
| 23 | Presidio Mining Co. | Texas | Shafter | Siliceous (silver) ores. |
| 24 | United Verde Mining Co. | Arizona | Verde | Copper ores. |
| 25 | Empire Zinc Co. | Colorado | Red Cliff | Pyritic ores. |

## MINE PRODUCTION OF GOLD AND SILVER, BY STATES.

### ALASKA.

The total production of gold in Alaska from the earliest mining in 1880 to the end of 1922 is estimated at $335,526,460, and that of silver at 11,463,592 fine ounces.

*Gold.*—The yield from siliceous ores decreased from $3,818,226 in 1921 to $3,012,211 in 1922, and that from copper ores decreased from $27,471 to $15,064; the placer output increased from $4,226,000 to $4,395,000. Twenty-three dredges produced $1,767,753 of the placer gold, which was $185,233 more than the dredge output in 1921.

The 2,513,455 tons of siliceous ores treated in 1922 yielded an average of $1.23 in gold and silver a ton, and the 581,384 tons of copper ore contained $1.10 in gold and silver a ton.

About 41 per cent of the total output of gold in Alaska came from gold lode mines in 1922, against 47 per cent in 1921, 53 per cent in 1920, 47 per cent in 1919, 37 per cent in 1918, 31 per cent in 1917, and 29 per cent in 1912. The 627 placers operated in 1922 yielded 5,226,000 cubic yards of auriferous gravel, of which the dredges handled 3,186,343 cubic yards and made an average recovery of 55 cents a cubic yard in 1922, against 57 cents in 1921, 69 cents in 1920, 77 cents in 1919, and 57 cents in 1918. The estimated total recovery of gold by dredging for the period 1903–1922 is $24,875,205.

No important new placer-bearing areas were operated in 1922.

*Silver.*—The mine production of silver in Alaska in 1922 was 729,945 fine ounces, against 761,085 ounces in 1921. The copper mines produced 623,518 ounces, an increase of 78,289 ounces; the siliceous ores 71,346 ounces, against 99,515 ounces in 1921; and the placers 26,369 ounces, against 22,565 ounces. Lead ores yielded 8,712 ounces in 1922 and 93,776 ounces in 1921.

### ARIZONA.

*Gold.*—The mine production of gold in Arizona in 1922 was $3,524,134, or $593,831 more than in 1921. Placers contributed only $11,981. The deep mines produced $3,512,153, of which 64 per cent came from dry and siliceous ores mined chiefly in Mohave, Cochise, and Yavapai counties, and 34 per cent was contained in copper ores mined chiefly in Cochise and Yavapai counties. Mohave County had a gold output of $2,100,728, Cochise County of $755,733, and Yavapai County of $464,101. The gold recovered from ores treated at gold and silver mills represented about 60 per cent of the total deep-mine output, against 80 per cent in 1921, and crude ores shipped to smelters contained about 36 per cent. The crude copper ores mined and smelted directly (without previous concentration) contained an average gold output of about 73 cents a ton.

*Silver.*—The mine production of silver in Arizona increased from 2,469,394 fine ounces in 1921 to 4,531,864 ounces in 1922. Of this output 2,766,277 ounces came from copper ores, 1,012,558 ounces from dry and siliceous ores, 744,559 ounces from lead ores, and 8,357 ounces from copper-lead ores. Cochise County produced 2,655,673 ounces in 1922, of which 1,324,294 ounces came from copper ores and 786,890 ounces from siliceous ores; and Yavapai County produced 949,331 ounces, derived mainly from copper ores. Bullion recovered from gold and silver ores, almost all by cyanidation, contained 152,128 ounces of silver, concentrates 478,339 ounces, and crude ore shipped to smelters 3,883,494 ounces.

## CALIFORNIA.

*Gold.*—In 1922 the deep mines of California produced $9,170,491 in gold (an increase of $1,620,493), of which gold-quartz ores yielded 98.3 per cent. California placers in 1922 produced $5,499,855 in gold, or $2,654,969 less than in 1921. Of the placer production $4,999,215 was recovered by dredging. The total dredge production from 1896 to the end of 1922 has been $129,999,199, and the production by dredges in 1922 was equal to 34 per cent of the total gold for 1922. The Yuba County dredges, 10 in number, made the largest output, the value being $2,485,405, a decrease of $2,237,159. Sacramento County, with 7 dredges working, made an output of $1,349,413, a decrease of $338,233. In Butte County (including Oroville and other districts) 4 dredges produced $454,294 in gold, or $34,277 more than in 1921. Dredges were also operated in Calaveras, Amador, Stanislaus, Placer, Shasta, and Trinity counties.

Six of the 31 counties reporting mine production of gold each had a yield of more than $1,000,000 in 1922. Of these Yuba and Sacramento counties obtained most of their gold by dredging, Amador and Calaveras counties are on the Mother Lode, Nevada County produced mainly from siliceous ores of the Grass Valley district, and Sierra County from siliceous ores. The five Mother Lode counties—Amador, Calaveras, Eldorado, Mariposa, and Tuolumne—whose output is mainly gold milling ores, produced $2,812,336 in gold from mill bullion and $876,572 from concentrates in 1922, against $2,820,455 from mill bullion and $863,102 from concentrates in 1921.

*Silver.*—The mine production of silver in California in 1922 was 3,100,065 fine ounces, a decrease of 529,158 ounces. Siliceous ores yielded 2,472,489 ounces, copper ores 320,977 ounces, lead ores 263,681 ounces, zinc ores 15,390 ounces, copper-lead ores 7,915 ounces, and placers the remainder. The only counties producing more than 100,000 ounces of silver in 1922 were Inyo, Plumas, and San Bernardino. About 62 per cent of the silver was recovered from crude ores sent to smelters.

## COLORADO.

*Gold.*—The total mine production of gold in Colorado in 1922 was $6,373,419, a decrease of $461,909, following decreases of $740,991 in 1921, $2,310,308 in 1920, $2,865,091 in 1919, $2,977,506 in 1918, and $3,424,597 in 1917. The Cripple Creek district, with a decrease of $254,301, produced $4,037,582 in gold, or 63 per cent of the State output from all sources.

The San Juan region, in Dolores, La Plata, Ouray, San Juan, and San Miguel counties, produced $1,263,779; and Lake County produced $413,058, an increase of $103,914. Siliceous and dry ores, 92 per cent of all the ore sold or treated, yielded 93 per cent of the total output of gold; a little more than 1.27 per cent came from lead ore, 5.6 per cent from placers, and the remainder from ore of other classes. The gold recovered by amalgamation from 259,536 tons of ore amounted to 91,495 fine ounces, and that recovered by cyanidation from 432,653 tons of ore to 126,054 fine ounces.

The placer production in 1922 was $356,403, an increase of $11,763. Dredges in Summit County produced more than 69 per cent of the placer gold.

*Silver.*—The mine production of silver in Colorado in 1922 was 5,855,911 fine ounces, an increase of 224,254 ounces. Lake County, principally Leadville, produced 952,048 ounces, a decrease of 91,449 ounces. San Miguel County produced 1,645,459 ounces, a decrease of 131,504 ounces. Eagle County produced 583,737 ounces and Ouray County 1,226,670 ounces. Siliceous and dry ores yielded nearly 90 per cent of the silver recovered, and lead ores 8.4 per cent.

IDAHO.

*Gold.*—The mine production of gold in Idaho in 1922 was $501,405, a decrease of $44,326. The total production of gold in Idaho from the discovery of placer gold in 1863 to the end of 1922 is estimated by C. N. Gerry [3] at $133,859,749.

Boise County produced about 30 per cent of the total output in 1922. The lode mines produced $317,433 in gold and the placers $183,972, of which $158,827 was won by dredging. The total output of gold recovered by dredges from 1897 to the end of 1922 has been $4,598,387. Of the total gold in 1922, about 36.7 per cent came from placers, 37.5 per cent from siliceous ores, 8.4 per cent from copper ores, and the remainder from lead and copper-lead ores.

*Silver.*—The mine production of silver in Idaho in 1922 was 6,081,865 fine ounces, or 1,337 ounces more than in 1921. The total silver from Idaho for the period 1863 to 1922, inclusive, amounts to 258,946,538 fine ounces.[3]

Shoshone County produced 77 per cent of the total silver in 1922, 82 per cent in 1921, 87 per cent in 1920, 86 per cent in 1919, 92 per cent in 1918, and 93.4 per cent in 1917. Lead ores contained 90 per cent of the output of silver in 1922 and copper-lead ores 7.6 per cent. Crude ore shipped, which averaged 18.19 ounces of silver a ton, supplied about 27 per cent of the silver, and concentrates, which averaged 22.79 ounces of silver a ton, contained 72.7 per cent.

MICHIGAN.

The copper mines of Michigan produced 376,990 fine ounces of silver in 1922, against 310,727 fine ounces in 1921. The silver was derived mainly from the electrolytic treatment of about 31,100,000 pounds of copper. The average recovery of silver per ton of "rock" treated was 0.27 ounce.

MISSOURI, OKLAHOMA, ILLINOIS, AND KENTUCKY.

The lead and zinc mines of the Central States produce no gold and only a small quantity of silver. Nearly all the silver is a by-product from the refining of lead from concentrates of lead ores mined in southeastern Missouri. The total yield of silver from Missouri in 1922 was 212,656 fine ounces, which was derived from lead recovered from 138,000 tons of galena concentrates.

The lead-zinc-fluorspar deposits of the Kentucky-Illinois field carry silver, and from the lead concentrates shipped in 1922 from Illinois 6,025 ounces of silver was recovered, against 1,345 ounces in 1921. The average silver recovery from lead concentrates from Illinois in 1922 was 5.48 ounces a ton. No silver ore was shipped from the Criswell mine, near Byars, McClain County, Okla., in 1922.

[3] U. S. Geol. Survey Mineral Resources, 1922, pt. 1, p. 217, 1923.

### MONTANA.

*Gold.*—The mine production of gold in Montana increased from $1,480,763 in 1921 to $1,656,757 in 1922. The placer output was $71,786, a decrease of $155,375. Madison County had the largest placer output, $38,577, nearly all of which was recovered by one company, which operated a dredge in Alder Gulch. Lewis and Clark County produced $255,279, mostly from gold ores, and Silver Bow County $543,746, chiefly from copper and silver ores. At amalgamation and cyanidation plants $577,164 in gold was recovered, an average of $3.67 per ton of ore and tailings treated. Ore treated at concentration mills yielded concentrates containing $616,120, or $0.59 a ton, and crude ore shipped to smelters contained $381,955 in gold, an average of $1.93 a ton.

*Silver.*—Montana mines produced 12,468,151 fine ounces of silver in 1922, an increase of 5,909,438 ounces. The copper ores yielded 5,446,684 ounces (an average of 1.7 ounces a ton), of which Silver Bow County (Butte) supplied 5,437,026 ounces. The lead-zinc ores produced 2,391,872 ounces. The dry and siliceous ores produced 2,197,802 ounces, of which Silver Bow County supplied 1,084,445 ounces from silver ores.

### NEVADA.

*Gold.*—The mine production of gold in Nevada in 1922 was $3,297,384, against $3,312,757 in 1921. The Goldfield district produced $264,041, against $146,782 in 1921. Nye County produced $1,548,170, of which $1,179,302 was from Tonopah, whose increase was $180,208.

*Silver.*—The mine production of silver in Nevada in 1922 was 8,619,587 fine ounces, against 7,083,782 ounces in 1921. Nye County (almost wholly the Tonopah district) again led, with 5,553,563 ounces, 853,853 ounces more than in 1921. All but 809,730 ounces came from dry and siliceous ores, and 86.4 per cent of the State output was recovered by cyanidation.

### NEW MEXICO.

*Gold.*—The mine production of gold in New Mexico in 1922 was $412,693, against $196,822 in 1921. Catron County produced $142,133; Hidalgo County, $115,511; Grant County, $48,071; Colfax County, $77,813.

Copper ores contained 6,806 ounces of gold, against 630 ounces in 1921, and dry and siliceous ores contained 12,857 ounces. The output from lead ore was very small, and the placer output was only about 190 ounces.

*Silver.*—The mine production of silver in New Mexico increased from 571,899 fine ounces in 1921 to 752,240 ounces in 1922. Catron County produced 322,460 fine ounces, all from siliceous ores. Copper ores yielded 111,624 ounces, and lead and copper-lead ores only 25,766 ounces. The output of silver from Grant County increased from 106,272 ounces in 1921 to 150,844 ounces in 1922.

### OREGON.

*Gold.*—The mine production of gold in Oregon decreased from $882,034 in 1921 to $531,568 in 1922. The placer mines produced

$346,137, or $132,596 less than in 1921. Of the output from deep mines 69 per cent was obtained from siliceous ores. The deep mines of the State produced $185,431, a decrease of $217,870. Three dredges in Baker County and one dredge in Grant County produced $269,994, and a few drift and hydraulic mines and surface placers in Baker, Coos, Curry, Douglas, Grant, Harney, Jackson, Josephine, Malheur, Union, and Wheeler counties produced the remainder of the placer gold. Baker and Grant counties produced more than $100,000 in gold each.

*Silver.*—The mine production of silver in Oregon in 1922 was 151,812 fine ounces, an increase of 109,692 ounces. Of the total production 134,396 ounces came from siliceous ores, 14,405 ounces from copper ores, and 3,011 ounces from placer bullion.

## SOUTH DAKOTA.

The total value of the gold produced in South Dakota from 1876 to the end of 1922 is given by Charles W. Henderson,[4] of the United States Geological Survey, as $236,746,624, and the total output of silver for the same period as 7,032,217 fine ounces.

*Gold.*—The mine production of gold in South Dakota in 1922 was $6,517,788, against $6,605,167 in 1921. The output was almost wholly from siliceous milling ores of low grade. More than 69 per cent of the deep-mine output was recovered by amalgamation, and the remainder by cyanidation. The Homestake mines and mills produced $6,285,318 in gold bullion from 1,663,485 tons of ore treated. The small yield of placer gold (88 ounces) came from Pennington and Grant counties. The very small placer output of Custer County did not reach a market before 1923.

*Silver.*—The mine output of silver, derived mainly from refining the gold bullion produced, was 118,760 fine ounces, or 6,296 ounces more than in 1921.

## SOUTHERN APPALACHIAN STATES.

*Gold.*—The total production of gold from 1799 to the end of 1922 in the southern Appalachian States, as shown from data compiled by the Bureau of the Mint and the United States Geological Survey, has been $51,055,432. The figures credit Alabama with $766,632, Georgia with $17,829,190, North Carolina with $23,634,259, Tennessee with $273,922, Virginia with $3,298,032, South Carolina with $5,181,992, and Maryland with $71,405.

The combined mine production of gold in the southern Appalachian States in 1922 was $10,221, against $9,934 in 1921. Tennessee led with $4,320; Georgia was next, with $3,224. The gold produced in Tennessee was derived from copper ores of the Ducktown district. The production of gold from placers amounted to 110.78 ounces. Copper ores in Tennessee yielded about 209 ounces of gold, and siliceous ores in North Carolina, Georgia, and Virginia yielded about 150.5 ounces.

*Silver.*—Copper ores in Tennessee yielded 78,341 ounces of silver in 1922, and copper-lead ores in Georgia 350 ounces. Siliceous ores and placer bullion yielded only 29 ounces.

[4] U. S. Geol. Survey Mineral Resources, 1922, pt. 1, p. 194, 1923.

### TEXAS.

The total output of gold from Texas mines from 1885 to the end of 1922 is given by Charles W. Henderson as $43,607, and the output of silver for the same period was 16,455,480 ounces.

*Gold.*—The small annual yield of gold has been mainly a by-product, and none has been reported since 1919.

*Silver.*—The mine production of silver from Texas in 1922 was 644,980 fine ounces, against 516,766 ounces (revised figures) in 1921. The greater part of the silver continued to come from the Presidio mine, and the remainder was derived from small shipments of copper ore and lead ore from Hudspeth County.

### UTAH.

*Gold.*—The total output of gold in Utah from 1864 to 1922, inclusive, is given by V. C. Heikes,[5] of the United States Geological Survey, as $104,309,290.

The mine production of gold increased from $1,769,905 in 1921 to $2,296,855 in 1922. The Bingham district, Salt Lake County, produced $1,187,355, and the Tintic district, partly in Juab County and partly in Utah County, produced $465,321. The placer gold in 1922 amounted to $2,130, and the output recovered by cyanidation and amalgamation was about $212,660. About 32.8 per cent of the Utah gold was derived from copper ores mined mainly in Salt Lake and Juab counties; lead and lead-zinc ores contained 32.6 per cent; and siliceous ores 34.5 per cent.

*Silver.*—The total output of silver in Utah from 1864 to 1922, inclusive, has been 433,756,159 fine ounces, according to Heikes.[5]

The mine production of silver in Utah in 1922 was 17,271,100 ounces, an increase of 5,019,102 ounces. The largest production was made in Juab County, credited with 6,338,689 ounces, mainly from lead ores, against 5,031,030 ounces in 1921. Utah County had 2,217,547 ounces, mostly from lead and siliceous ores, against 2,559,368 ounces in 1921. Of the Salt Lake County output of 1,678,618 ounces, the Bingham district produced 1,381,299 ounces. The Tintic district, in Juab and Utah counties, produced 8,533,954 ounces, mainly from lead and siliceous ores; and the Park City region, in Summit and Wasatch counties, produced 5,245,194 ounces, all from lead and siliceous ores. Altogether in 1922 the lead ores of Utah yielded 8,183,741 ounces of silver, the copper ores 473,284 ounces, the copper-lead ores 20,919 ounces, and the dry and siliceous ores 8,110,733 ounces. The crude ore smelted in 1922 contained 12,940,173 ounces, and concentrates contained 2,737,644 ounces.

### WASHINGTON.

The total production of gold in Washington from earliest mining to the end of 1922 is given by C. N. Gerry,[6] of the United States Geological Survey, as $28,442,523, and the total production of silver as 8,170,091 fine ounces.

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[5] U. S. Geol. Survey Mineral Resources, 1922, pt. 1, p. 377, 1923.
[6] Idem, p. 245.

*Gold.*—The mine production of gold in Washington in 1922 was $186,965, against $128,486 in 1921. Of this production 46 per cent was derived from ores shipped directly to smelters, and 51 per cent came from gold and silver milling plants; siliceous ores supplied 97.6 per cent and copper ores and lead ores together less than 1 per cent. Ferry County alone produced $85,686 in 1922, against $88,290 in 1921. Nearly all the gold produced in Ferry County came, as usual, from mines in the Republic district. Whatcom County produced $95,679 in gold.

*Silver.*—The mine production of silver in Washington increased from 142,450 ounces in 1921 to 205,046 ounces in 1922, of which Ferry County produced 32,725 ounces, mainly from siliceous ores; Stevens County 103,108 ounces, mainly from copper ores; and Okanogan County 68,312 ounces, mainly from siliceous ores.

## WYOMING.

The total production of gold in Wyoming from 1867 to the end of 1922 is given by Charles W. Henderson[7] as $1,237,328, and the output of silver for the same period as 69,859 ounces.

Small shipments of copper ore containing gold, silver, platinum, and palladium were made from the Old Rambler mine. Small placer mines produced some bullion in 1922. The total output of gold in 1922 was valued at $1,207.

## PHILIPPINE ISLANDS.

*Gold.*—The output of gold in the Philippine Islands from 1907 to 1922, inclusive, has been $14,475,301.

The mine production of gold in 1922 was $1,526,400, against $1,313,096 in 1921, $1,276,561 in 1920, $1,309,722 in 1919, $1,290,000 in 1918, $1,408,161 in 1917, $1,514,200 in 1916, $1,320,900 in 1915, $1,371,514 in 1914, $868,362 in 1913, and $570,212 in 1912.

The milling plant of the Benguet Consolidated Mining Co., in the Province of Luzon, the largest producer of gold in the Philippine Islands, is described in the Mining and Scientific Press of December 4 and 11, 1920. Another large producer was the Colorado mine, at Araroy.

*Silver.*—The mine production of silver in the Philippine Islands in 1922 was 27,994 ounces and was recovered entirely from gold bullion refined, as no attempt was made to develop the known deposits of silver ore.

The annual report of the Benguet Consolidated Mining Co. for 1922 stated that 42,244 tons of ore was cyanided. The extraction was 91.8 per cent of the average value of the ore, and the bullion recovered was valued at $865,521. During the year 9,294 feet of workings were cut and the mine ore bodies between B and C levels were developed. The ore reserves were estimated to be 316,000 tons at the end of 1922. The capacity of the mill was being increased to 200 tons a day, and the greater capacity and the improvement in the treatment of ore will lower the limit of ore that can be mined to about $6 a ton.

[7] U. S. Geol. Survey Mineral Resources, 1922, pt. 1, p. 197, 1923.

## NUMBER OF PRODUCING MINES.

The following table indicates the number of mines producing gold and silver in 1922. The placers are those in which the gold and the silver in natural alloy with the gold and, in a few placers, with platinum also are recovered from gravels and sands, whether by hand washing, sluicing, hydraulicking, drifting (in frozen ground or ancient buried river channels), or dredging. The deep mines are those producing gold and silver (from ores as distinguished from gravels) mainly from underground workings, including those whose ores are valuable chiefly for copper, lead, or zinc but which contribute precious metals as by-products. In addition to producing mines here enumerated, many properties were being prospected and developed (though prospecting and development were less active than usual) without making any output in 1922, and many other mining claims were being held by assessment work only.

The enumeration of placer mines is less satisfactory than that of deep mines, because some of the operations are only temporary and individually small and because much of the production is made by transitory miners not regularly working placer ground. The unit so far as possible is, however, as for deep mines, not the operator, but the mining claim or group of claims.

*Number of mines in the United States producing gold and silver in 1922.*[a]

| State. | Placer. | Deep. | Total. | State. | Placer. | Deep. | Total. |
|---|---|---|---|---|---|---|---|
| Alaska | 627 | 36 | 663 | Oregon | 126 | 44 | 170 |
| Arizona | 33 | 285 | 318 | Pennsylvania [b] | ..... | 1 | 1 |
| California | 282 | 283 | 565 | South Carolina | 1 | ..... | 1 |
| Colorado | 21 | 459 | 480 | South Dakota | 3 | 3 | 6 |
| Georgia | 6 | 5 | 11 | Tennessee [b] | ..... | 2 | 2 |
| Idaho | 94 | 154 | 248 | Texas | ..... | 4 | 4 |
| Illinois [b] | ..... | 4 | 4 | Utah | 7 | 147 | 154 |
| Michigan [b] | ..... | 4 | 4 | Virginia | ..... | 1 | 1 |
| Missouri [b] | ..... | 2 | 2 | Washington | 13 | 33 | 46 |
| Montana | 78 | 315 | 393 | Wyoming | 5 | 1 | 6 |
| Nevada | 42 | 345 | 387 | | | | |
| New Mexico | 17 | 74 | 91 | | 1,359 | 2,206 | 3,565 |
| North Carolina | 4 | 4 | 8 | | | | |

[a] Philippine Islands not included.
[b] Number of mines contributing to production of gold and silver

*Number of mines producing gold and silver, 1906–1922.*

| Year. | Placer. | Deep. | Total. | Year. | Placer. | Deep. | Total. |
|---|---|---|---|---|---|---|---|
| 1906 | 2,316 | 2,114 | 4,430 | 1916 | 1,530 | 3,765 | 5,295 |
| 1907 | 2,586 | 2,604 | 5,190 | 1917 | 1,552 | 3,811 | 5,363 |
| 1908 | 2,599 | 2,864 | 5,463 | 1918 | 1,414 | 3,287 | 4,701 |
| 1909 | 2,187 | 3,183 | 5,370 | 1919 | 1,105 | 2,460 | 3,565 |
| 1910 | 2,026 | 3,299 | 5,325 | 1920 | 1,012 | 2,331 | 3,343 |
| 1911 | 2,146 | 3,553 | 5,699 | 1921 | 1,357 | 1,967 | 3,324 |
| 1912 | 2,044 | 3,567 | 5,611 | 1922 | 1,359 | 2,206 | 3,565 |
| 1913 | 1,774 | 3,502 | 5,276 | | | | |
| 1914 | 1,815 | 3,158 | 4,973 | Average | 1,796 | 3,016 | 4,812 |
| 1915 | 1,720 | 3,597 | 5,317 | | | | |

The total number of properties operated in 1922 was 1,247 less than the average for the last 17 years. The number of placer properties worked in 1922 showed an increase of 2, and the total was 957 less than the number operated in 1906. This is a natural result of the exhaustion of the rich gravel and of the acquisition of large areas of placer ground by dredge mining companies. The number of deep

mines operated was 239 more than in 1921 and 810 less than the average for 17 years, and fewer deep mines were operated than in any other year except 1906 and 1921.

### ORE PRODUCTION, CLASSIFICATION, AND AVERAGE VALUE.

The best index of deep mining is, of course, found in the quantity, metallic content, and value of ore mined, rather than in the number of mines or of operators. In the next following table are given the production of ore from mines producing gold and silver and the average extraction value of precious metals per ton.

The classification adopted is necessarily arbitrary in part. The complex nature of western ores especially and the gradations from one well-recognized class to another render essential a fixed terminology. The dry and siliceous ores comprise gold and silver ores proper, as well as fluxing ores carrying considerable quantities of iron and manganese oxides and very small quantities of gold and silver, and precious metal bearing ores carrying copper, lead, or zinc in quantities too low to classify them as copper, lead, zinc, or mixed ores. The distinction between gold and silver ores is not here made. The total number of silver mines and the total production of true silver ores are both very small. The copper ores include those containing 2.5 per cent or more of copper, or less than this percentage in the great disseminated copper deposits of the West and in the Lake Superior ores; in general, the lead ores are those containing 4.5 per cent or more of lead and the zinc ores are those containing 25 per cent or more of zinc, both irrespective of their precious-metal content; but ores of lower grades in lead and expecially in zinc are treated profitably in many districts, and of course they are then classified as lead or zinc ores, as the case may be. The mixed ores are combinations of those enumerated.

The lead, zinc, and lead-zinc ores in many districts in the Eastern and Central States carry no appreciable quantity of gold or silver, and such ores are excluded from this report.

The total quantity of ore sold or treated from which gold or silver was produced had increased more than 20,350,000 tons in the four years prior to 1920 and had decreased 23,791,863 tons in 1921, but it increased from 21,567,328 tons in 1921 to 35,176,410 tons in 1922. In 1922 copper ores sold or treated, owing to the increased activities of the large mines, increased 12,425,240 tons, zinc ores 461,056 tons, lead-zinc ores 322,558 tons, lead ores 70,098 tons, and copper-lead ores 38,122 tons. The quantity of dry and siliceous ores increased only 292,008 tons.

Arizona led in quantity of ore, as its output is mainly copper ore. Utah was second, owing to its copper, lead, and siliceous ores. Montana was third, with an output of more than 4,385,000 tons of ore, of which about 74 per cent was copper ore. Alaska, South Dakota, New Mexico, Nevada, California, Idaho, Colorado, Michigan, and Tennessee followed in order of output of ore. The bulk of the ore from South Dakota, Alaska, Colorado, and California was low-grade siliceous ore, and that from Idaho was mainly lead ore. As many copper mines resumed work the copper ore attained the usual proportion maintained during recent years. For the second time in several years the larger part of the output of ore from Nevada was dry and siliceous ore, although the production of copper ores was

much larger in 1922 than in 1921. All the ore from Michigan was low-grade copper ore, and about 94 per cent of the ore treated from New Mexico was copper ore.

*Ore produced in the United States and average extraction value of gold and silver per ton in 1922.*[a]

| State or Territory. | Dry and siliceous ores. | | Copper ores. | | Lead ores. | |
|---|---|---|---|---|---|---|
| | Short tons. | Average value. | Short tons. | Average value. | Short tons. | Average value. |
| Alaska | 2,513,455 | $1.23 | 581,384 | $1.10 | 79 | $111.44 |
| Arizona | 246,286 | 13.21 | 10,431,729 | .38 | 67,138 | 12.24 |
| California | 1,052,148 | 10.91 | 447,200 | .98 | 26,466 | 11.10 |
| Colorado | 1,296,501 | 8.61 | 863 | 49.79 | 48,381 | 11.87 |
| Georgia | 160 | 6.31 | | | | |
| Idaho | 25,766 | 10.84 | 32,590 | 2.66 | 1,331,785 | 4.13 |
| Michigan [b] | | | 1,400,000 | .27 | | |
| Montana | 373,311 | 8.84 | 3,250,213 | 1.76 | 96,203 | 7.33 |
| Nevada | 871,883 | 12.29 | 629,408 | .17 | 39,462 | 19.26 |
| New Mexico | 78,127 | 11.27 | 1,477,166 | .17 | 3,038 | 5.61 |
| North Carolina | 255 | 5.53 | | | | |
| Oregon | 10,405 | 25.28 | 17,117 | 4.19 | | |
| Pennsylvania [c] | | | 15,141 | .32 | | |
| South Dakota | 1,751,454 | 3.79 | | | | |
| Tennessee [d] | | | 557,750 | .15 | | |
| Texas | 69,300 | 9.27 | 73 | 5.16 | 47 | 46.13 |
| Utah | 414,339 | 21.49 | 4,509,384 | .27 | 507,450 | 16.85 |
| Virginia | 50 | 14.24 | | | | |
| Washington | 24,782 | 11.65 | 6,086 | 11.34 | 3,624 | 8.48 |
| Wyoming | | | 24 | 7.67 | | |
| | 8,728,222 | 6.98 | 23,356,128 | .56 | 2,123,673 | 8.24 |
| Percentage | 24.81 | | 66.40 | | 6.04 | |
| 1921: Total | [e] 8,436,214 | 6.65 | 10,930,888 | .54 | 2,053,575 | 7.89 |
| Percentage | 39.11 | | 50.68 | | 9.52 | |

| State or Territory. | Zinc ores. | | Copper-lead and copper-lead-zinc ores. | | Lead-zinc ores. | | Total (short tons). |
|---|---|---|---|---|---|---|---|
| | Short tons. | Average value. | Short tons. | Average value. | Short tons. | Average value. | |
| Alaska | | | | | | | 3,094,918 |
| Arizona | | | 435 | $20.02 | 457 | | 10,746,045 |
| California | 14,072 | $1.87 | 47 | 172.79 | | | 1,539,933 |
| Colorado | 43,615 | .01 | 627 | 62.46 | 22,113 | $2.10 | 1,412,100 |
| Georgia | | | 600 | 1.42 | | | 760 |
| Idaho | 84 | | 26,143 | 18.87 | 20,516 | 1.68 | 1,436,884 |
| Michigan [b] | | | | | | | 1,400,000 |
| Montana | 399,330 | 4.28 | 21,251 | 6.39 | 245,570 | 10.10 | 4,385,878 |
| Nevada | 1,158 | | 102 | 21.49 | 23,263 | 3.76 | 1,565,276 |
| New Mexico | 9,781 | | 1,893 | 5.82 | 6,915 | | 1,576,920 |
| North Carolina | | | | | | | 255 |
| Oregon | | | | | | | 27,522 |
| Pennsylvania [c] | | | | | | | 15,141 |
| South Dakota | | | | | | | 1,751,454 |
| Tennessee [d] | | | | | | | 557,750 |
| Texas | | | | | | | 69,420 |
| Utah | 1,578 | | 1,272 | 17.02 | 126,011 | 6.84 | 5,560,034 |
| Virginia | | | | | | | 50 |
| Washington | 1,554 | .03 | | | | | 36,046 |
| Wyoming | | | | | | | 24 |
| | 471,172 | 3.68 | 52,370 | 13.76 | 444,845 | 7.89 | 35,176,410 |
| Percentage | 1.34 | | 0.15 | | 1.26 | | 100.00 |
| 1921: Total | 10,116 | .76 | 14,248 | 31.76 | 122,287 | 16.96 | [e] 21,567,328 |
| Percentage | 0.05 | | 0.07 | | 0.57 | | 100.00 |

[a] Philippine Islands, Illinois, and Missouri not included; quantity of crude ore containing gold and silver not known.
[b] Includes copper ore only that yielded silver.
[c] From low-grade copper concentrates derived from pyritiferous magnetite ore. The recovery given is that per ton of concentrates.
[d] Zinc ore and lead ore yielded no gold or silver.
[e] Revised figures.

Some of the States produced comparatively small quantities of copper ore containing considerable gold and silver, but the copper ores of the major copper-producing States contained very little gold and silver. In 1922 the lead ores of Utah showed an average recovery in gold and silver of $16.85 a ton, and the lead ores of Idaho, the leading State, only $4.13 a ton. In the output of ore considered as producing gold and silver, the proportion of dry and siliceous ore decreased greatly, being 24.8 per cent, compared with about 39 per cent in 1921, the proportion of lead ores decreased from 9.5 to 6 per cent, whereas that of copper ores increased from 50 to 66 per cent. The proportion of other classes of ore, which together comprise only 2.75 per cent of the total, also increased considerably. The average value per ton in gold and silver of siliceous ores, copper ores, lead ores, and zinc ores increased in 1922, whereas that of copper-lead and lead-zinc decreased.

The following table shows that copper ores comprised 66.3 per cent of the ore containing gold and silver mined and treated during the period 1906–1922, dry and siliceous ores 24.3 per cent, and all the other classes of ore 9.4 per cent. The peak of production of dry and siliceous ores was reached in 1916, though the proportion of such ores to the total was largest in 1906. The extraction value varies considerably in different years, depending to a large degree on the quantity of low-grade ores milled in Alaska and South Dakota. The quantity of copper ores exceeded that of dry and siliceous ores by only 1,250,000 tons in 1906, whereas in 1918 the excess was about 43,700,000 tons, owing to the great activity at the large properties having low-grade disseminated deposits of copper ore. The output of copper ores during the last four years was very much less than in the years 1916–1918. The decided decrease in the average extraction value of gold and silver in copper ores was caused by the low gold and silver content in the greatly increased quantity of copper ores derived from mines in Arizona, New Mexico, Nevada, and Utah. The average extraction value of gold and silver was only 56 cents a ton in 1922, against $1.55 a ton in 1906. In 1914, owing to the low price of silver, the average extraction value was only 49 cents. The quantity of lead ore containing gold or silver mined and treated during the period 1906–1922 has ranged from 1,815,243 tons in 1919 to 2,563,904 tons in 1913. As silver predominates over gold in most of the lead ore the average extraction value shows a wider range than the quantity of ore. Zinc ores comprised less than 1 per cent of the total ore given in the following table, and the average extraction value in precious metals shows a considerable range. The copper-lead and copper-lead-zinc ores have been negligible in quantity but show a higher average extraction value than any other class of ore. The lead-zinc ores containing gold and silver decreased greatly in 1921 and 1922, though they comprise about 3 per cent of the total ores given in the table and have averaged in gold and silver nearly $3 a ton.

*Ore produced in the United States and average extraction value of gold and silver per ton, 1906–1922.*[a]

| Year. | Dry and siliceous ores. | | Copper ores. | | Lead ores. | |
|---|---|---|---|---|---|---|
| | Short tons. | Average value. | Short tons. | Average value. | Short tons. | Average value. |
| 1906 | 9,230,616 | $7.87 | 10,483,308 | $1.55 | 2,270,822 | $5.08 |
| 1907 | 8,080,601 | 8.27 | 20,031,684 | .74 | 2,354,426 | 5.81 |
| 1908 | 9,633,939 | 7.28 | 14,041,795 | .91 | 2,392,030 | 3.55 |
| 1909 | 9,755,650 | 7.65 | 18,152,224 | .83 | 2,243,840 | 4.65 |
| 1910 | 9,646,294 | 8.07 | 19,145,677 | .74 | 2,081,545 | 4.44 |
| 1911 | 10,623,884 | 7.50 | 21,384,408 | .67 | 2,157,817 | 4.39 |
| 1912 | 10,584,777 | 7.40 | 26,761,390 | .63 | 2,388,598 | 4.85 |
| 1913 | 10,656,738 | 7.15 | 30,850,693 | .54 | 2,563,904 | 4.98 |
| 1914 | 10,966,666 | 6.95 | 27,653,352 | .49 | 2,307,550 | 5.29 |
| 1915 | 12,687,126 | 6.26 | 32,973,166 | .51 | 2,429,546 | 4.86 |
| 1916 | 12,921,268 | 5.73 | 47,478,127 | .51 | 2,373,579 | 5.95 |
| 1917 | 12,166,026 | 5.56 | 49,049,181 | .49 | 2,494,077 | 6.88 |
| 1918 | 9,702,240 | 6.58 | 53,409,729 | .50 | 2,356,585 | 8.24 |
| 1919 | 9,302,229 | 6.25 | 29,919,369 | .61 | 1,815,243 | 9.33 |
| 1920 | 8,590,139 | 6.26 | 32,447,410 | .52 | 2,368,619 | 8.26 |
| 1921 | [b]8,436,214 | 6.65 | 10,930,888 | .54 | 2,053,575 | 7.89 |
| 1922 | 8,728,222 | 6.98 | 23,356,128 | .56 | 2,123,673 | 8.24 |
| | 171,712,629 | 6.86 | 468,071,529 | .60 | 38,775,429 | 5.99 |
| Percentage | 24.3 | | 66.3 | | 5.5 | |

| Year. | Zinc ores. | | Copper-lead and copper-lead-zinc ores. | | Lead-zinc ores. | | Total (short tons). |
|---|---|---|---|---|---|---|---|
| | Short tons. | Average value. | Short tons. | Average value. | Short tons. | Average value. | |
| 1906 | 68,296 | $1.18 | 608,180 | $9.53 | 575,605 | $3.07 | 23,236,827 |
| 1907 | 34,859 | 5.17 | 71,781 | 10.46 | 1,048,592 | .97 | 31,624,943 |
| 1908 | 69,177 | .64 | 67,971 | 15.82 | 249,934 | 2.01 | 26,445,846 |
| 1909 | 58,173 | 3.68 | 32,193 | 20.18 | 322,477 | 2.42 | 30,564,557 |
| 1910 | 322,008 | 1.46 | 20,318 | 15.11 | 502,070 | 2.67 | 31,717,912 |
| 1911 | 425,280 | .89 | 6,923 | 25.17 | 924,478 | 1.80 | 35,522,890 |
| 1912 | 377,737 | 1.35 | 14,614 | 30.80 | 967,690 | 2.05 | 41,094,806 |
| 1913 | 231,547 | .31 | 24,399 | 22.61 | 1,427,027 | 2.48 | 45,754,308 |
| 1914 | 622,811 | .19 | 11,577 | 12.87 | 1,488,747 | 2.90 | 43,050,703 |
| 1915 | 512,634 | 1.32 | 10,951 | 15.55 | 1,900,029 | 2.06 | 50,513,452 |
| 1916 | 833,345 | 1.21 | 79,992 | 5.54 | 2,702,091 | 2.31 | 66,388,402 |
| 1917 | 641,755 | .90 | 31,675 | 14.58 | 2,793,613 | 2.82 | 67,176,327 |
| 1918 | 210,298 | .76 | 15,698 | 16.19 | 2,352,350 | 3.47 | 68,046,900 |
| 1919 | 88,654 | .52 | 17,632 | 15.97 | 1,365,945 | 4.91 | 42,509,072 |
| 1920 | 482,229 | 3.00 | 26,890 | 30.01 | 1,443,904 | 4.10 | 45,359,191 |
| 1921 | 10,116 | .76 | 14,248 | 31.76 | 122,287 | 16.96 | [b]21,567,328 |
| 1922 | 471,172 | 3.68 | 52,370 | 13.76 | 444,845 | 7.89 | 35,176,410 |
| | 5,460,191 | 1.42 | 1,107,412 | 12.25 | 20,622,684 | 2.97 | 705,749,874 |
| Percentage | 0.8 | | 0.2 | | 2.9 | | 100.0 |

[a] Philippine Islands, Porto Rico, Illinois, and Missouri excluded. Crude ore containing gold and silver not known.
[b] Revised figures.

## DISTRIBUTION OF MINE PRODUCTION OF GOLD, BY SOURCES.

As shown in the following table, more than 91.5 per cent of the domestic output of gold is obtained from dry and siliceous ore—normally gold quartz and gold-silver quartzose ores—and from placers. The total contribution of gold derived from the great copper, lead, and zinc mines of the country is therefore relatively small, notwithstanding their recent enormous development and production of ore, and this contribution in 1922 was greater than in 1921, owing to the larger quantities of base ores treated.

The contribution of gold from dry and siliceous ores, which had gradually declined from 69 per cent in 1910 to 66 per cent in 1914 and has fluctuated since then, was 66 per cent in 1921 and 68 per cent

in 1922. The contribution of gold from copper ores increased from 6 per cent in 1914 to 9.6 per cent in 1918, decreased to 6.78 per cent in 1919, increased to 7.18 per cent in 1920, decreased to 2.25 per cent in 1921, and increased to 5.71 per cent in 1922.

*Mine production of gold in the United States in 1922, by States, in fine ounces.*[a]

| State or Territory. | Placers. | Dry and siliceous ores. | Copper ores. | Lead ores. | Zinc ores. | Copper-lead and copper-lead-zinc ores. | Lead-zinc ores. | Total. |
|---|---|---|---|---|---|---|---|---|
| Alaska | 212,608.13 | 145,715.70 | 728.72 | 4.45 | | | | 359,057.00 |
| Arizona | 579.58 | 108,415.11 | 57,745.04 | 3,723.28 | | 16.97 | | 170,479.98 |
| California | 266,055.51 | 435,902.39 | 5,728.85 | 1,451.81 | 529.48 | 9.95 | | 709,677.99 |
| Colorado | 17,241.00 | 286,220.31 | 556.47 | 3,906.13 | 1.20 | 84.47 | 304.57 | 308,314.15 |
| Georgia | 83.35 | 48.42 | | | | 24.19 | | 155.96 |
| Idaho | 8,899.64 | 9,084.94 | 2,045.78 | 2,590.10 | | 1,635.00 | | 24,255.46 |
| Montana | 3,472.65 | 53,343.24 | 13,367.13 | 2,783.02 | 2,276.81 | 659.18 | 4,243.59 | 80,145.62 |
| Nevada | 11,602.36 | 140,506.36 | 4,400.63 | 2,979.85 | | 1.90 | 19.85 | 159,510.95 |
| New Mexico | 190.21 | 12,856.99 | 6,805.80 | 111.02 | | | | 19,964.02 |
| North Carolina and South Carolina. | 27.43 | 67.92 | | | | | | 95.35 |
| Oregon | 16,744.36 | 6,198.73 | 2,771.51 | | | | | 25,714.60 |
| Pennsylvania | | | 125.78 | | | | | 125.78 |
| South Dakota | 87.99 | 315,210.00 | | | | | | 315,297.99 |
| Tennessee | | | 208.98 | | | | | 208.98 |
| Utah | 103.04 | 38,353.62 | 36,398.64 | 17,853.25 | | 35.14 | 18,366.67 | 111,110.36 |
| Virginia | | 34.15 | | | | | | 34.15 |
| Washington | 162.44 | 8,830.87 | 38.40 | 12.72 | | | | 9,044.43 |
| Wyoming | 52.00 | | 6.39 | | | | | 58.39 |
| | 537,909.69 | 1,560,788.75 | 130,928.12 | 35,415.63 | 2,807.49 | 2,466.80 | 22,934.68 | 2,293,251.16 |
| Value | $11,119,580 | $32,264,367 | $2,706,525 | $732,106 | $58,036 | $50,993 | $474,102 | $47,405,709 |
| Percentage | 23.46 | 68.06 | 5.71 | 1.54 | 0.12 | 0.11 | 1.00 | 100.00 |
| 1921: Total | 677,435.36 | 1,548,251.12 | 52,765.14 | 61,923.93 | 75.49 | 158.91 | 4,399.78 | 2,345,009.73 |
| Value | $14,003,832 | $32,005,191 | $1,090,753 | $1,280,081 | $1,560 | $3,285 | $90,952 | $48,475,654 |
| Percentage | 28.89 | 66.02 | 2.25 | 2.64 | 0.003 | 0.007 | 0.19 | 100.00 |

[a] Philippine Islands not included.

## PLACERS.

### GENERAL FEATURES.

The production of gold from placer mining in 1922 was $2,884,252 less than in 1921. The States showing a considerable increase in placer gold were Alaska (8,175 ounces), Colorado (569 ounces), and Idaho (115 ounces). The largest decreases were in California (128,434 ounces), Montana (7,516 ounces), Oregon (6,414 ounces), and Nevada (5,965 ounces).

The placer gold is derived chiefly from dredging (which yielded 69 per cent of the total in 1922), from drift mining (which is of decreasing importance in Alaska in frozen ground at no great depth, but of continued importance in California in ancient buried river channels, in places at considerable depth), and from hydraulic and sluicing placers. In California, especially, hydraulic mining was of much importance in the past and had become a special branch of the industry in itself but has in recent years been greatly reduced by restrictive laws relative to the débris and to disturbance of navigable streams. Finally, there is a small annual output of gold from dry placers in the Southwest and also of gold and platinum from ocean-beach mining in California and Oregon.

Some interesting notes on beach mining in California and Oregon and on dry placers in California, by Charles G. Yale, and on dry placers in Arizona, Nevada, and New Mexico, by V. C. Heikes, were published in the Survey report on gold and silver for 1912, copies of which may still be had on application to the Director, United States Geological Survey, Washington, D. C.

DREDGING.

The value of gold produced by dredging in the United States from the commercial beginning of the industry in 1896 to the end of 1922 has amounted, according to the best available data, to $180,853,446, of which $129,999,199 came from California, $24,875,205 from Alaska, $9,592,435 from Montana, $7,013,096 from Colorado, $4,598,387 from Idaho, and $4,206,854 from Oregon. The production of gold from dredges in 1922 was much less than in 1921, though the number of dredges operated in 1922 was only one less than in 1921.

Brief details of dredging operations have been given in Mineral Resources in the mine reports on gold, silver, copper, lead, and zinc in the Western States and also in earlier reports of the Director of the Mint. A brief history of gold dredging in the United States was given in the general report on gold and silver for the year 1914, and the production of gold obtained by dredging in the United States and the number of dredges operated were given by States for each year from 1896 to the end of 1914. Further information is to be found in reports of geological surveys or mining officials of different States. A comprehensive and very useful report is contained in Bulletin 57 of the California State Mining Bureau. Other valuable treatises are "Dredging for gold in California," by D'Arcy Weatherbe, published by the Mining and Scientific Press, and Bulletins 121 and 127 of the Bureau of Mines.

*Gold produced in the United States by dredges, 1896–1922.*

| Year. | Dredges. | California. | Alaska. | All other States.[a] | Total. |
|---|---|---|---|---|---|
| 1896 | 2 | $2,000 | ..... | $42,000 | $44,000 |
| 1897 | 6 | 5,000 | ..... | 113,556 | 118,556 |
| 1898 | 8 | 18,887 | ..... | 168,813 | 187,700 |
| 1899 | 18 | 206,302 | ..... | 227,876 | 434,178 |
| 1900 | 27 | 200,929 | ..... | 319,108 | 520,037 |
| 1901 | 34 | 471,762 | ..... | 268,251 | 740,013 |
| 1902 | 48 | 867,665 | ..... | 501,857 | 1,369,522 |
| 1903 | 45 | 1,475,749 | $20,000 | 420,315 | 1,916,064 |
| 1904 | 61 | 2,187,038 | 25,000 | 511,679 | 2,723,717 |
| 1905 | 68 | 3,276,141 | 40,000 | 371,235 | 3,687,376 |
| 1906 | 76 | 5,098,359 | 120,000 | 503,035 | 5,721,394 |
| 1907 | 79 | 5,065,437 | 250,000 | 340,265 | 5,655,702 |
| 1908 | 88 | 6,536,189 | 171,000 | 646,481 | 7,353,670 |
| 1909 | 96 | 7,382,950 | 425,000 | 975,656 | 8,783,605 |
| 1910 | 115 | 7,550,254 | 800,000 | 942,786 | 9,293,040 |
| 1911 | 119 | 7,666,461 | 1,500,000 | 1,159,908 | 10,326,369 |
| 1912 | 124 | 7,429,955 | 2,200,000 | 1,588,956 | 11,218,911 |
| 1913 | 116 | 8,090,294 | 2,200,000 | 1,936,642 | 12,226,936 |
| 1914 | 120 | 7,783,394 | 2,350,000 | 2,379,389 | 12,512,783 |
| 1915 | 114 | 7,796,465 | 2,330,000 | 2,356,660 | 12,483,125 |
| 1916 | 113 | 7,769,227 | 2,679,000 | 2,338,487 | 12,786,714 |
| 1917 | 109 | 8,313,527 | 2,500,000 | 1,736,898 | 12,550,425 |
| 1918 | 93 | 7,431,927 | 1,425,000 | 1,485,173 | 10,342,100 |
| 1919 | 91 | 7,716,919 | 1,360,000 | 1,269,297 | 10,346,216 |
| 1920 | 78 | 6,900,366 | 1,129,932 | 1,256,158 | 9,286,456 |
| 1921 | 72 | 7,756,787 | 1,582,520 | 1,196,261 | 10,535,568 |
| 1922 | 71 | 4,999,215 | 1,767,753 | 922,300 | 7,689,268 |
| | ..... | 129,999,199 | 24,875,205 | 25,979,042 | 180,853,446 |

[a] Other States that have produced gold by dredges are Colorado, which yielded in 1901–1922 $7,013,096; Idaho, 1897–1922, $4,598,387; Montana, 1896–1922, $9,592,435; Oregon, 1902–1922, $4,206,854; and New Mexico, Nevada, South Dakota, Wyoming, Washington, Alabama, Georgia, and North Carolina, combined, 1902–1922, $568,270.

Of the output in 1922 California produced $4,999,215 from 35 dredges, Alaska $1,767,753 from 23 dredges, Colorado $346,327 from 4 dredges, Idaho $158,827 from 3 dredges, Montana $36,941 from 1 dredge, and Oregon $269,994 from 4 dredges. One dredge was operated below Silver City, in Lyon County, Nev., by the Gold Canyon Dredging Co. during 1922 and produced $110,211.

## DRY AND SILICEOUS ORES.

The siliceous ores are in part free-milling (amalgamating), as in Alaska, California, Arizona, and Oregon; both amalgamating and concentrating, as in many States; simply concentrating ores, as in parts of Colorado and Arizona; all-sliming and cyaniding ores; and finally smelting ores. Tailings both from old dumps and from present millings are largely reworked by concentration and subsequent cyanidation. Owing to the increase in the cost of labor and supplies in the last five or six years, much of the old tailings could not be reworked at a profit.

The material smelted consists mainly of concentrates and of siliceous and pyritic ores, which are also valuable as fluxes. Exact figures of relative output by methods and by States are given in another table.

As most of the gold produced in the United States is derived from placer gravels and dry and siliceous ores, including true gold, gold-silver, and silver ores, the following table for certain States, prepared by V. C. Heikes, is of special interest.

*Gold produced in six Western States in 1916–1922.*

| Year. | Number of producers. | Ore mined (short tons). | Total gold (fine ounces).[a] | Gold ore. | | | |
|---|---|---|---|---|---|---|---|
| | | | | Number of producers. | Short tons. | Gold content (fine ounces). | |
| | | | | | | Total. | Average. |
| Arizona: | | | | | | | |
| 1916 | 527 | 17,033,810 | 192,801.41 | 105 | 164,918 | 63,562.20 | 0.385 |
| 1917 | 484 | 15,770,193 | 245,173.83 | 86 | 236,585 | 128,801.16 | .544 |
| 1918 | 469 | 19,038,486 | 262,919.43 | 63 | 201,411 | 141,126.20 | .700 |
| 1919 | 339 | 13,727,403 | 217,997.72 | 34 | 190,069 | 125,188.13 | .659 |
| 1920 | 318 | 14,920,478 | 231,528.65 | 41 | 201,334 | 139,857.94 | .694 |
| 1921 | 215 | 5,455,030 | 141,753.41 | 26 | 182,194 | 114,044.05 | .63 |
| 1922 | 318 | 10,746,045 | 170,479.98 | 72 | 173,070 | 102,814.10 | .59 |
| Idaho: | | | | | | | |
| 1916 | 418 | 2,718,045 | 53,977.30 | 75 | 69,443 | 25,068.38 | .361 |
| 1917 | 359 | 2,758,507 | 38,932.64 | 70 | 67,784 | 24,721.63 | .365 |
| 1918 | 301 | 2,091,619 | 33,998.72 | 53 | 41,481 | 13,774.92 | .332 |
| 1919 | 210 | 1,457,395 | 34,502.89 | 31 | 44,537 | 21,989.06 | .493 |
| 1920 | 163 | 1,958,401 | 23,490.42 | 17 | 38,534 | 13,708.33 | .355 |
| 1921 | 225 | 1,514,447 | 26,399.73 | 29 | 47,174 | 13,710.44 | .29 |
| 1922 | 248 | 1,436,884 | 24,255.46 | 36 | 21,580 | 8,734.16 | .40 |
| Montana: | | | | | | | |
| 1916 | 513 | 7,860,425 | 220,130.15 | 150 | 498,082 | 131,175.61 | .263 |
| 1917 | 617 | 6,307,164 | 170,147.11 | 137 | 411,118 | 103,835.48 | .252 |
| 1918 | 493 | 7,823,967 | 150,192.96 | 90 | 234,663 | 74,996.31 | .320 |
| 1919 | 457 | 4,183,594 | 107,856.32 | 87 | 130,922 | 56,301.56 | .430 |
| 1920 | 457 | 5,241,615 | 89,550.11 | 60 | 98,307 | 38,284.51 | .389 |
| 1921 | 445 | 1,324,801 | 71,631.91 | 104 | 96,504 | 41,684.11 | .43 |
| 1922 | 393 | 4,385,878 | 80,145.62 | 77 | 161,900 | 42,695.72 | .26 |
| Nevada: | | | | | | | |
| 1916 | 779 | 5,941,165 | 428,904.21 | 308 | 817,100 | 232,699.56 | .285 |
| 1917 | 943 | 6,473,519 | 336,664.26 | 287 | 589,228 | 171,815.15 | .292 |
| 1918 | 714 | 6,472,579 | 320,239.45 | 195 | 540,320 | 167,878.58 | .311 |
| 1919 | 421 | 3,187,831 | 219,695.16 | 94 | 163,279 | 111,170.33 | .681 |
| 1920 | 473 | 3,480,620 | 172,540.46 | 106 | 102,772 | 48,873.75 | .476 |
| 1921 | 431 | 1,096,138 | 160,254.62 | 122 | 63,850 | 50,699.95 | .79 |
| 1922 | 387 | 1,565,276 | 159,510.95 | 108 | 69,337 | 57,954.24 | .84 |
| Utah: | | | | | | | |
| 1916 | 318 | 13,920,643 | 172,938.06 | 10 | 1,308 | 663.82 | .508 |
| 1917 | 334 | 15,358,481 | 162,305.67 | 6 | 14,728 | 4,678.60 | .318 |
| 1918 | 250 | 14,705,718 | 142,666.10 | 10 | 222 | 359.70 | 1.620 |
| 1919 | 179 | 6,745,423 | 104,464.41 | 6 | 553 | 1,528.81 | 2.764 |
| 1920 | 164 | 6,800,180 | 97,454.15 | 3 | 19 | 85.00 | 4.473 |
| 1921 | 138 | 2,137,522 | 85,619.15 | 2 | 69 | 266.69 | 3.86 |
| 1922 | 154 | 5,560,034 | 111,110.36 | 4 | 36,624 | 15,924.48 | .43 |
| Washington: | | | | | | | |
| 1916 | 113 | 164,998 | 27,944.06 | 38 | 70,048 | 26,932.84 | .384 |
| 1917 | 136 | 172,119 | 23,816.17 | 23 | 65,058 | 23,166.31 | .356 |
| 1918 | 84 | 138,911 | 14,737.83 | 23 | 45,434 | 14,070.56 | .309 |
| 1919 | 49 | 100,879 | 12,232.20 | 11 | 25,648 | 11,951.91 | .465 |
| 1920 | 44 | 85,318 | 5,846.60 | 10 | 12,513 | 5,510.88 | .440 |
| 1921 | 37 | 22,885 | 6,215.51 | 9 | 15,985 | 5,966.77 | .37 |
| 1922 | 46 | 36,046 | 9,044.43 | 10 | 17,944 | 8,764.15 | .49 |

[a] Includes placer production, given in last column on p. 623.

*Gold produced in six Western States in 1916–1922*—Continued.

| Year. | Gold-silver ore. | | Silver ore. | | Placers. | |
|---|---|---|---|---|---|---|
| | Short tons. | Gold (fine ounces). | Short tons. | Gold (fine ounces). | Number of producers. | Gold (fine ounces). |
| Arizona: | | | | | | |
| 1916 | 1,470 | 994.00 | 169,916 | 8,858.47 | 23 | 690.84 |
| 1917 | 1 | 3.62 | 80,817 | 3,192.79 | 32 | 832.73 |
| 1918 | 2,415 | 452.21 | 91,722 | 8,421.19 | 13 | 204.82 |
| 1919 | 19,536 | 6,474.19 | 85,070 | 4,279.51 | 15 | 227.07 |
| 1920 | 1,177 | 236.75 | 78,190 | 9,423.34 | 8 | 220.93 |
| 1921 | 75 | 23.67 | 50,932 | 2,390.05 | 37 | 605.85 |
| 1922 | 2,031 | 1,351.19 | 71,185 | 4,249.82 | 33 | 579.58 |
| Idaho: | | | | | | |
| 1916 | 447 | 227.19 | 1,793 | 201.15 | 162 | 21,724.87 |
| 1917 | ..... | ..... | 1,866 | 207.64 | 112 | 6,541.80 |
| 1918 | ..... | ..... | 4,834 | 478.53 | 85 | 13,371.33 |
| 1919 | 21 | 15.94 | 3,693 | 257.08 | 72 | 9,227.63 |
| 1920 | 5 | 9.55 | 1,272 | 88.49 | 49 | 5,505.76 |
| 1921 | 54 | 39.14 | 993 | 76.96 | 92 | 8,784.90 |
| 1922 | 257 | 193.81 | 3,929 | 156.97 | 94 | 8,899.64 |
| Montana: | | | | | | |
| 1916 | 999 | 176.45 | 24,761 | 4,075.20 | 120 | 34,982.82 |
| 1917 | 7 | 2.20 | 33,097 | 3,335.15 | 99 | 22,594.17 |
| 1918 | 233 | 121.33 | 51,626 | 5,495.86 | 86 | 19,167.72 |
| 1919 | 118 | 61.58 | 90,646 | 7,926.41 | 62 | 14,097.92 |
| 1920 | 847 | 423.20 | 79,198 | 6,585.71 | 65 | 13,977.76 |
| 1921 | 1,401 | 715.66 | 67,001 | 4,978.18 | 97 | 10,988.91 |
| 1922 | 6,594 | 1,079.35 | 204,817 | 9,568.17 | 78 | 3,472.65 |
| Nevada: | | | | | | |
| 1916 | 13,330 | 2,681.38 | 721,211 | 116,039.39 | 65 | 17,139 89 |
| 1917 | 17,614 | 3,099.45 | 807,087 | 93,757.16 | 91 | 14,153.75 |
| 1918 | 14,384 | 3,157.77 | 839,879 | 82,026.71 | 54 | 10,564.13 |
| 1919 | 68,874 | 28,478.76 | 551,414 | 54,358.94 | 37 | 6,399.43 |
| 1920 | 76,863 | 24,216.14 | 619,572 | 62,968.62 | 39 | 7,383.91 |
| 1921 | 60,365 | 18,969.68 | 543,345 | 63,625.31 | 61 | 17,566.99 |
| 1922 | 44,503 | 10,189.16 | 758,043 | 72,362.96 | 42 | 11,602.36 |
| Utah: | | | | | | |
| 1916 | 4,337 | 1,130.41 | 83,718 | 7,328.18 | 8 | 60.47 |
| 1917 | 25,318 | 4,864.68 | 124,011 | 10,851.33 | 3 | 5.42 |
| 1918 | 5 | 101.75 | 227,129 | 22,353.99 | 3 | 66.18 |
| 1919 | 14,618 | 3,489.71 | 224,517 | 20,198.11 | ..... | ..... |
| 1920 | 24,837 | 10,209.30 | 266,164 | 23,053.69 | 3 | 21.91 |
| 1921 | 33,616 | 11,769.97 | 342,787 | 17,517.44 | 4 | 20.03 |
| 1922 | 4,145 | 2,178.47 | 373,570 | 20,250.67 | 7 | 103.04 |
| Washington: | | | | | | |
| 1916 | ..... | ..... | 428 | 46.19 | 23 | 400.40 |
| 1917 | 48 | 30.89 | 533 | 43.41 | 17 | 283.86 |
| 1918 | ..... | ..... | 1,717 | 36.80 | 10 | 165.93 |
| 1919 | ..... | ..... | 3,438 | 65.02 | 7 | 60.32 |
| 1920 | ..... | ..... | 583 | 38.94 | 9 | 71.20 |
| 1921 | ..... | ..... | 4,214 | 48.61 | 11 | 148.66 |
| 1922 | ..... | ..... | 6,838 | 66.72 | 13 | 162.44 |

Nearly all the siliceous ore in three of the largest gold-producing States—Alaska, California, and South Dakota—yields only a small quantity of silver and is classed as gold ore. The siliceous ores from Colorado include some silver and gold-silver ores, but the great bulk of the siliceous ore is purely gold ore.

*Siliceous ore treated and gold recovered per ton of ore treated in 1913–1922.*

| Year. | Alaska. | | California. | | South Dakota. | | Colorado. | |
|---|---|---|---|---|---|---|---|---|
| | Ore treated. | Recovery per ton. | Ore treated. | Recovery per ton. | Ore treated. | Recovery per ton. | Ore treated. | Recovery per ton. |
| | *Short tons.* | *Ounce.* | *Short tons.* | *Ounce.* | *Short tons.* | *Ounce.* | *Short tons.* | *Ounce.* |
| 1913 | 1,614,506 | 0.144 | 2,031,429 | 0.267 | 1,899,139 | 0.187 | 2,161,458 | 0.378 |
| 1914 | 1,738,127 | .135 | 2,050,797 | .264 | 2,019,255 | .175 | 2,157,762 | .414 |
| 1915 | 3,020,607 | .097 | 2,368,352 | .272 | 1,889,970 | .189 | 2,183,431 | .464 |
| 1916 | 3,548,798 | .081 | 2,192,078 | .262 | 1,870,721 | .193 | 2,057,452 | .412 |
| 1917 | 3,414,664 | .065 | 2,018,003 | .246 | 1,867,859 | .191 | 1,996,590 | .347 |
| 1918 | 2,095,577 | .080 | 1,538,960 | .261 | 1,781,569 | .178 | 1,760,222 | .322 |
| 1919 | 3,262,573 | .068 | 1,212,142 | .339 | 1,330,349 | .177 | 1,667,076 | .258 |
| 1920 | 3,413,736 | .063 | 788,136 | .439 | 1,356,098 | .167 | 1,224,081 | .257 |
| 1921 | 2,894,813 | .064 | 902,566 | .402 | 1,725,669 | .185 | 1,230,172 | .250 |
| 1922 | 2,513,455 | .058 | 1,052,148 | .414 | 1,751,454 | .180 | 1,296,501 | .221 |

The quantity of siliceous ores treated in South Dakota in 1922 increased, but the recovery of gold per ton was slightly smaller; the siliceous ore in California increased 149,582 tons, and the gold recovery per ton was the second largest recorded for 10 years.

### COPPER ORES.

The gold obtained as a by-product in the smelting of copper ores sold or treated in 1922 showed an increase in quantity and a very large increase in percentage of the total gold yield, though the percentage was less than in 1920. The largest producer was Arizona, followed by Utah, Montana, New Mexico, California, and Nevada.

### LEAD ORES.

The gold in lead ores sold or treated in 1922 came chiefly from Utah, Colorado, Arizona, Nevada, Montana, and Idaho and showed a decrease compared with the output in 1921.

### LEAD-ZINC, ZINC, AND MIXED ORES.

The production of gold from zinc, lead-zinc, copper-lead, and copper-lead-zinc ores in 1922 was about six times as great as the production in 1921. Utah and Montana produced nearly all the gold from lead-zinc ores, and Montana and California produced most of the gold from zinc ores. Idaho and Montana contributed nearly all the gold from copper-lead ore.

### PRODUCTION OF GOLD, BY SOURCES, 1905–1922.

As shown in the following table, giving the source of the output of gold in the United States during the period 1905–1922, dry and siliceous ores yielded 65.7 per cent of the total, placer mining 25.4 per cent, copper ores 6.4, and all other ores 2.5 per cent. It is evident that there can be no great increase from the last-named ores. The yield from copper ores may increase, but no probable gain will bring the output of gold from copper ore to more than $5,000,000 or $6,000,000. The yield of gold from placers in 1922 was less than half that of the average of the years 1906–1916, and though there may be spasmodic increases during the next few years, it is practically certain that the output from this source will decline owing to the steady exhaustion of ground capable of being worked with dredges. Apparently any large increases in the yield of gold must come from dry and siliceous ores, which have yielded two-thirds of the output in the last 18 years. As the production from the dry and siliceous ores has decreased more than 50 per cent since 1915, as no new large bodies of ores of that class have been discovered, and as some of the low-grade siliceous ore can not be worked on account of the increased cost of mining and milling, there is apparently no reason to expect that the annual yield of gold from mines in the United States will exceed $50,000,000 to $55,000,000.

*Gold produced in the United States, by sources, as reported by mines, 1905–1922, in fine ounces.*[a]

| Year. | Placers. | Dry and siliceous ores. | Copper ores. | Lead ores. | Zinc ores. | Copper-lead and copper-lead-zinc ores. | Lead-zinc ores. | Total. |
|---|---|---|---|---|---|---|---|---|
| 1905 | 934,709 | 2,962,147 | 255,568 | 66,067 | 1,941 | 38,771 | 5,531 | 4,264,734 |
| 1906 | 1,328,361 | 2,970,875 | 271,197 | 60,812 | 693 | 59,371 | 11,691 | 4,703,000 |
| 1907 | 1,192,890 | 2,625,547 | 272,150 | 108,441 | 5,739 | 20,693 | 2,039 | 4,227,499 |
| 1908 | 1,239,240 | 2,882,120 | 232,829 | 51,057 | 1,194 | 23,799 | 4,924 | 4,435,163 |
| 1909 | 1,307,901 | 3,112,534 | 272,442 | 76,296 | 2,447 | 17,597 | 9,097 | 4,798,314 |
| 1910 | 1,089,206 | 3,159,521 | 264,669 | 54,281 | 2,953 | 847 | 13,426 | 4,584,903 |
| 1911 | 1,132,709 | 3,210,610 | 263,648 | 58,128 | 2,110 | 1,123 | 17,292 | 4,685,620 |
| 1912 | 1,113,575 | 3,004,664 | 262,388 | 65,214 | 4,881 | 2,300 | 12,489 | 4,465,511 |
| 1913 | 1,075,784 | 2,864,901 | 275,634 | 73,880 | 896 | 4,697 | 15,311 | 4,311,103 |
| 1914 | 1,117,931 | 2,940,873 | 264,832 | 74,514 | 1,913 | 548 | 17,451 | 4,418,062 |
| 1915 | 1,077,432 | 3,212,298 | 343,226 | 84,449 | 4,975 | 2,496 | 29,599 | 4,754,475 |
| 1916 | 1,106,901 | [b] 2,795,764 | [b] 401,127 | 71,922 | 8,302 | 4,452 | 28,539 | 4,417,007 |
| 1917 | 1,026,062 | 2,416,985 | 341,117 | 68,464 | 6,085 | 4,474 | 37,022 | 3,900,209 |
| 1918 | 758,202 | 2,045,495 | 309,018 | 55,246 | 1,188 | 1,431 | 42,093 | 3,212,673 |
| 1919 | 704,377 | 1,780,567 | 186,701 | 41,945 | 86 | 1,043 | 38,563 | 2,753,282 |
| 1920 | 603,002 | 1,523,331 | 171,055 | 46,776 | 3,657 | 3,731 | 31,435 | 2,382,987 |
| 1921 | 677,435 | 1,548,251 | 52,765 | 61,924 | 76 | 159 | 4,400 | 2,345,010 |
| 1922 | 537,910 | 1,560,789 | 130,928 | 35,415 | 2,807 | 2,467 | 22,935 | 2,293,251 |
| | 18,023,627 | 46,617,272 | 4,571,294 | 1,154,831 | 51,943 | 189,999 | 343,837 | 70,952,803 |
| Percentage | 25.4 | 65.7 | 6.4 | 1.6 | 0.1 | 0.3 | 0.5 | 100.0 |

[a] Philippine Islands and Porto Rico excluded.
[b] Revised figures.

## DISTRIBUTION OF MINE PRODUCTION OF SILVER, BY SOURCES.

*Mine production of silver in the United States in 1922, by States, in fine ounces.*[a]

| State or Territory. | Placers. | Dry and siliceous ores. | Copper ores. | Lead ores. | Zinc ores. | Copper-lead and copper-lead-zinc ores. | Lead-zinc ores. | Total. |
|---|---|---|---|---|---|---|---|---|
| Alaska | 26,369 | 71,346 | 623,518 | 8,712 | | | | 729,945 |
| Arizona | 113 | 1,012,558 | 2,766,277 | 744,559 | | 8,357 | | 4,531,864 |
| California | 19,613 | 2,472,489 | 320,977 | 263,681 | 15,390 | 7,915 | | 3,100,065 |
| Colorado | 4,228 | 5,248,758 | 31,463 | 493,697 | 291 | 37,418 | 40,056 | 5,855,911 |
| Georgia | 6 | 8 | | | | 350 | | 364 |
| Idaho | 1,959 | 91,377 | 44,550 | 5,450,038 | | 459,529 | 34,412 | 6,081,865 |
| Illinois [b] | | | | 6,025 | | | | 6,025 |
| Michigan | | | 376,990 | | | | | 376,990 |
| Missouri | | | | 212,656 | | | | 212,656 |
| Montana | 652 | 2,197,802 | 5,446,684 | 647,754 | 1,661,234 | 122,153 | 2,391,872 | 12,468,151 |
| Nevada | 4,710 | 7,809,857 | 17,127 | 698,590 | | 2,153 | 87,150 | 8,619,587 |
| New Mexico | 39 | 614,811 | 111,624 | 14,751 | | 11,015 | | 752,240 |
| North Carolina | 2 | 7 | | | | | | 9 |
| Oregon | 3,011 | 134,396 | 14,405 | | | | | 151,812 |
| Pennsylvania | | | 2,215 | | | | | 2,215 |
| South Dakota | 7 | 118,753 | | | | | | 118,760 |
| Tennessee | | | 78,341 | | | | | 78,341 |
| Texas | | 642,435 | 377 | 2,168 | | | | 644,980 |
| Utah | 6 | 8,110,733 | 473,284 | 8,183,741 | | 20,919 | 482,417 | 17,271,100 |
| Virginia | | 6 | | | | | | 6 |
| Washington | 49 | 106,243 | 68,239 | 30,463 | 52 | | | 205,046 |
| Wyoming | 5 | | 52 | | | | | 57 |
| | 60,769 | 28,631,579 | 10,376,123 | 16,756,835 | 1,676,967 | 669,809 | 3,035,907 | 61,207,989 |
| Value | $60,769 | $28,631,579 | $10,376,123 | $16,756,835 | $1,676,967 | $669,809 | $3,035,907 | $61,207,989 |
| Percentage | 0.10 | 46.78 | 16.95 | 27.38 | 2.74 | 1.09 | 4.96 | 100.00 |
| 1921: Total | 81,375 | [c] 24,117,251 | [c] 4,782,538 | 14,912,990 | 6,163 | 449,417 | 1,983,222 | [c] 46,332,956 |
| Value | $81,375 | [c] $24,117,251 | $4,782,538 | $14,912,990 | $6,163 | $449,417 | $1,983,222 | [c] $46,332,956 |
| Percentage | 0.18 | 52.05 | 10.32 | 32.19 | 0.01 | 0.97 | 4.28 | 100.00 |

[a] Philippine Islands not included.
[b] Fluorspar-lead ores.
[c] Revised figures.

The mine production of silver in 1922 from the three chief sources of silver—dry and siliceous ores, copper ores, and lead ores—was 91.11 per cent of the total, against 94.56 per cent in 1921. The proportionate percentage of the total output from dry and siliceous ores decreased from 52 per cent in 1921 to 47 per cent in 1922, that from lead ores from 32 to 27 per cent, that from lead-zinc ores increased from 4.3 to 5 per cent, and that from copper ores from 10 to 17 per cent. The combined yield of silver from placer bullion, zinc ores, and copper-lead ores was only 3.93 per cent of the total.

### PLACERS.

The output of silver from the refining of placer gold was 20,606 ounces less than in 1921. Of the total production about 76 per cent came from Alaska and California.

### DRY AND SILICEOUS ORES.

About 27 per cent of the mine production of silver from dry and siliceous ores was from Nevada (chiefly from the Tonopah district), more than 28 per cent from Utah (mainly from the Tintic district), and more than 18 per cent from Colorado. There were increases in the quantity of silver from siliceous ores in nearly all States, especially in Utah, Nevada, Montana, Colorado, and Arizona.

A large part of the silver from gold-silver siliceous ores is obtained with the gold by amalgamation and cyanidation in the mills, and the silver is then recovered by refining the mill bullion. The remainder is produced by smelting the richer ores and refining the copper or lead bullion produced. A small quantity of silver was also recovered from the leaching of copper ores.

### COPPER ORES.

The silver produced from copper ores is obtained in the electrolytic refining of Lake and blister copper produced by smelting. The copper ores are mainly sulphides (except the Lake ores of Michigan, which are native metal in amygdaloid and conglomerate matrix), and a greater quantity contains chalcocite than chalcopyrite or cupriferous pyrite. The silver tenor of the extensive disseminated deposits of the Santa Rita district, N. Mex., and of Ely, Nev., is notably low, but similar deposits elsewhere add considerable quantities of silver.

In output of silver from copper ores Montana continued to lead, with a yield of 5,446,684 ounces in 1922, against 1,663,472 ounces in 1921. Arizona was next, with 2,766,277 ounces in 1922, against 1,241,436 ounces in 1921; Alaska ranked third, with 623,518 ounces in 1922, against 545,229 ounces in 1921; and Utah produced 473,284 ounces in 1922, against 229,556 ounces in 1921. The production of Montana comes mainly from Butte, that of Arizona chiefly from Bisbee and Jerome, that of Utah from Tintic and Bingham, and that of California from Plumas County. Of these districts Bisbee well represents the disseminated type, Bingham produces from both lode and disseminated deposits, and the remainder produce silver chiefly from copper ore mined from deep lodes.

### LEAD ORES.

The mine production of silver from argentiferous lead ores increased considerably in 1922. The output from Idaho decreased 238,539 ounces, that of Utah increased 2,290,244 ounces, that of Colorado decreased 30,326 ounces, and that of Montana decreased 704,371 ounces. The yield of Idaho is derived mainly from the silver-lead ores of the Coeur d'Alene district, that in Utah chiefly from the Park City and Tintic districts, and that in Colorado from Aspen and Leadville. The production of silver from lead ores increased also in Arizona, California, Missouri, Nevada, and Washington. Most of the output is obtained from the desilverization of lead bullion from smelting of western ores and concentrates.

### ZINC, LEAD-ZINC, AND MIXED ORES.

Silver from argentiferous zinc ores increased more than 1,670,000 fine ounces in 1922. The output was mainly a refinery by-product from the smelting of zinc concentrates from California and Montana. Silver from lead-zinc ores increased 1,052,685 ounces; it came chiefly from Montana and Utah. The output of silver from copper-lead and copper-lead-zinc ores came mainly from Idaho, Montana, Colorado, and Utah.

### PRODUCTION OF SILVER, BY SOURCES, 1905-1922.

*Silver produced in the United States, by sources, as reported by mines, 1905–1922, in fine ounces.*[a]

| Year. | Placers. | Dry and siliceous ores. | Copper ores. | Lead ores. | Zinc ores. | Copper-lead and copper-lead-zinc ores. | Lead-zinc ores. | Total. |
|---|---|---|---|---|---|---|---|---|
| 1905 | 112,826 | 17,187,889 | 15,762,947 | 16,070,203 | 939,252 | 5,416,723 | 782,656 | 56,272,496 |
| 1906 | 171,058 | 16,792,799 | 15,880,870 | 15,328,653 | 98,423 | 6,815,678 | 2,274,972, | 57,362,453 |
| 1907 | 126,808 | 19,038,042 | 13,955,436 | 17,318,811 | 93,419 | 489,825 | 1,474,725 | 52,497,066 |
| 1908 | 159,285 | 19,862,038 | 14,945,189 | 11,049,481 | 37,605 | 1,099,283 | 722,906 | 50,875,787 |
| 1909 | 152,040 | 19,826,890 | 18,300,705 | 17,027,737 | 313,948 | 549,923 | 1,141,434 | 57,312,677 |
| 1910 | 159,381 | 23,125,042 | 16,024,543 | 15,028,076 | 755,369 | 535,987 | 1,968,311 | 57,596,709 |
| 1911 | 170,084 | 25,205,749 | 16,759,638 | 15,596,638 | 630,573 | 285,006 | 2,460,152 | 61,107,840 |
| 1912 | 163,955 | 26,363,436 | 18,744,661 | 16,632,377 | 664,421 | 654,596 | 2,810,939 | 66,034,385 |
| 1913 | 123,739 | 28,010,875 | 18,250,253 | 18,629,246 | 86,432 | 752,563 | 5,334,120 | 71,187,228 |
| 1914 | 152,128 | 27,812,335 | 14,829,828 | 19,302,081 | 145,264 | 248,866 | 7,132,747 | 69,623,249 |
| 1915 | 154,968 | 25,709,505 | 18,781,365 | 19,828,533 | 1,136,220 | 234,047 | 6,509,092 | 72,353,730 |
| 1916 | 126,351 | 24,593,656 | 24,541,234 | 19,216,586 | 1,274,292 | 533,273 | 8,572,141 | 78,857,533 |
| 1917 | 118,604 | 21,489,465 | 20,314,233 | 19,096,474 | 549,656 | 448,042 | 8,645,038 | 70,661,512 |
| 1918 | 89,494 | 21,564,982 | 20,462,597 | 18,291,243 | 135,676 | 224,580 | 7,290,380 | 68,058,952 |
| 1919 | 78,401 | 19,043,515 | 12,880,624 | 14,351,293 | 39,480 | 232,157 | 5,273,990 | 51,899,460 |
| 1920 | 73,383 | 20,477,612 | 12,151,424 | 17,069,506 | 1,258,341 | 669,503 | 4,837,135 | 56,536,904 |
| 1921 | 81,375 | [a]24,117,251 | 4,782,538 | 14,912,990 | 6,163 | 449,417 | 1,983,222 | [a]46,332,956 |
| 1922 | 60,769 | 28,631,579 | 10,376,123 | 16,756,835 | 1,676,967 | 669,809 | 3,035,907 | 61,207,989 |
| | 2,274,649 | 408,852,660 | 287,744,208 | 304,506,763 | 9,841,501 | 20,309,278 | 72,249,867 | 1,105,778,926 |
| Percentage | 0.2 | 37.0 | 26.0 | 27.5 | 0.9 | 1.8 | 6.6 | 100.0 |

[a] Revised figures.

The production of silver as reported by the mines had increased pretty steadily from 1908 to 1916. A decline during the next three years was followed by partial recovery in 1920, a further decline in 1921, and a considerable increase in 1922, when the output was 17,649,544 ounces less than it was in 1916. The recovery from dry and siliceous ores in 1922 exceeded by 620,704 ounces that in 1913, when the yield from the Tonopah mines was at its zenith, and

was 4,514,328 ounces more than it was in 1921. The yield of silver from copper ores in 1922 was 14,165,111 ounces less than the yield in 1916, when it reached the maximum. The combined production of silver from lead and lead-zinc ores increased from 16,896,212 ounces in 1921 to 19,792,742 ounces in 1922.

## DISTRIBUTION OF PRODUCTION OF GOLD AND SILVER, BY METHODS OF TREATMENT.

### SUMMARY OF DISTRIBUTION.

In the following table is given the recoverable gold and silver content of the ore, tailings, and slag treated in 1922.

*Distribution of gold and silver produced in the United States in 1922, by States.*[a]

| State or Territory. | Total quantity of crude ore, tailings, and slag treated or sold in 1922 (short tons). | Ore to gold and silver mills. | | | Crude ore to concentrating mills (short tons). | Concentrates from all sources. | | |
|---|---|---|---|---|---|---|---|---|
| | | Short tons. | Gold in bullion (fine ounces). | Silver in bullion (fine ounces). | | Short tons. | Gold (fine ounces). | Silver (fine ounces). |
| Alaska | 3,094,918 | 2,513,410 | 126,999 | 23,951 | 544,212 | 55,308 | 18,459 | 350,799 |
| Arizona | 10,746,045 | 190,254 | [b] 102,253 | [b] 152,128 | 7,633,387 | 470,809 | 6,597 | 478,339 |
| California | 1,539,933 | 936,132 | 372,480 | 92,753 | 546,132 | 58,594 | 63,264 | 1,078,019 |
| Colorado | 1,412,100 | 849,261 | 217,549 | 41,405 | 302,232 | 60,290 | 42,667 | 3,136,236 |
| Idaho | 1,436,884 | 21,662 | 8,644 | 4,350 | 1,254,566 | 194,075 | 3,543 | 4,423,717 |
| Montana | 4,385,878 | 133,714 | [c] 27,920 | [c] 93,972 | 2,997,339 | 1,039,017 | 29,805 | 9,749,808 |
| Nevada | 1,565,276 | 776,597 | [d] 135,145 | [d] 7,458,846 | 558,366 | 54,354 | 4,476 | 398,112 |
| New Mexico | 1,576,920 | 54,512 | 10,526 | 262,663 | 1,425,824 | 66,164 | 2,544 | 68,954 |
| Oregon | 27,522 | 2,705 | 2,297 | 639 | 18,538 | 4,231 | 5,157 | 20,470 |
| South Dakota | 1,751,454 | 1,751,454 | 315,210 | 118,753 | | | | |
| Texas | 69,420 | 69,300 | | 642,435 | | | | |
| Utah | 5,560,034 | 33,247 | 8,830 | 85,739 | 4,838,707 | 315,531 | 60,746 | 2,737,644 |
| Washington | 36,046 | 9,127 | 4,642 | 3,157 | 13,495 | 928 | 74 | 79,975 |
| Wyoming | 24 | | | | | | | |
| Eastern States | [e] 1,282,391 | 465 | 150 | 21 | [e] 862,616 | 27,148 | 167 | 21,854 |
| Total, 1921 | 34,484,845 | 7,341,840 | 1,332,645 | 8,980,812 | 20,995,414 | 2,346,449 | 237,499 | 22,543,927 |
| | [f] 20,422,328 | [f] 7,090,118 | 1,276,940 | [f] 7,620,200 | 9,350,671 | 974,551 | 245,152 | 14,278,976 |

| State or Territory. | Crude ore to smelters. | | | Ore leached and old slag and tailings treated. | | |
|---|---|---|---|---|---|---|
| | Short tons. | Gold (fine ounces). | Silver (fine ounces). | Short tons. | Gold (fine ounces). | Silver (fine ounces). |
| Alaska | 37,296 | 991 | 328,826 | | | |
| Arizona | 1,559,635 | 61,001 | 3,883,494 | 1,362,769 | 49 | 17,790 |
| California | 57,669 | 7,878 | 1,909,680 | | | |
| Colorado | 260,607 | 30,857 | 2,674,042 | | | |
| Idaho | 90,820 | 3,169 | 1,651,839 | 69,836 | | |
| Montana | 197,770 | 18,477 | 2,461,547 | 1,057,055 | 471 | 162,172 |
| Nevada | 141,119 | 5,801 | 550,598 | 89,194 | 2,487 | 207,321 |
| New Mexico | 96,584 | 6,704 | 420,584 | | | |
| Oregon | 6,279 | 1,516 | 127,692 | | | |
| South Dakota | | | | | | |
| Texas | 120 | | 2,545 | | | |
| Utah | 497,985 | 39,974 | 12,940,173 | 190,095 | 1,457 | 1,507,538 |
| Washington | 13,424 | 4,166 | 121,865 | | | |
| Wyoming | 24 | 6 | 52 | | | |
| Eastern States | 419,310 | 193 | 59,052 | | | |
| Total, 1921 | 3,378,642 | 180,733 | 27,131,989 | 2,768,949 | 4,464 | 1,894,821 |
| | 2,073,540 | 136,341 | 22,636,133 | 1,907,999 | 9,142 | 1,334,298 |

[a] Exclusive of silver from copper ores in Michigan, from lead and lead-fluorspar ores in Missouri and Illinois, and from siliceous ores in the Philippine Islands.
[b] Includes recoveries from 1,000 tons of old tailings.
[c] Includes recoveries from 23,730 tons of old tailings.
[d] Includes recoveries from 67,303 tons of old tailings.
[e] Includes low-grade pyritiferous magnetite ore from Pennsylvania.
[f] Revised figures.

The first column in the table takes no account of placer gravel but represents the output of mines producing ore only. The greatest output was made in Arizona, Utah, and Montana, all notable for large yields of copper ores; in Idaho, a large producer of lead ores; in Alaska, California, and Nevada, large producers of both copper and siliceous ores; in South Dakota and Colorado, large producers of siliceous ores; and in New Mexico, a large producer of copper ores.

Many gold and silver mills employ concentrating apparatus, and the concentrates they obtain are combined in the table with those from straight concentrating mills under the heading "Concentrates produced." The gold and silver included in this item are recovered partly by amalgamation and cyanidation, as is shown in detail in the table on page 631 of this report.

The figures for the quantity of ore treated by concentration include only the large quantities of copper, lead, zinc, and mixed ores whose concentrates are smelted primarily for these metals, the gold and silver being recovered in refining the copper and lead bullion and smelting the zinc residues. Examples are the copper ores of the disseminated deposits of Bingham, Utah, and of New Mexico and Nevada; the copper ores of Butte, Mont., and Ely, Nev.; and the lead and lead-zinc ores of Coeur d'Alene, Idaho, Butte, Mont., and Leadville, Colo. The quantity of concentrates produced and the recoverable gold and silver content represent not only the concentrates from these straight concentrating mills but also those from gold and silver mills, which form, however, a very small part of the total quantity of concentrates and are derived mainly from Alaska, California, and Colorado ores. These concentrates are mainly smelted but are also treated in gold and silver mills by the processes named.

The ore treated in straight concentration mills increased more than 100 per cent in 1922, mainly because of the resumption of operations at copper mines in Arizona, Montana, Nevada, Utah, and other States. Montana mills produced the largest quantity of concentrates, followed by those of Arizona, Utah, and Idaho. The recoverable gold content of concentrates came mainly from California, Utah, Colorado, Montana, Alaska, Arizona, Oregon, and Nevada. About 63 per cent of the recoverable silver from concentrates produced came from Montana and Idaho, and large quantities came from Colorado and Utah. The increase was due mainly to larger quantities of silver in concentrates derived from ores mined in Montana, Utah, California, Colorado, Nevada, and Arizona.

The figures for the quantity and the recoverable precious-metal content of crude ores shipped from the mines direct to the smelters in general include the richer gold, silver, copper, lead, and mixed ores from which the gold and silver is eventually recovered by refining the copper or lead bullion that collects the precious metals in the smelting. Arizona produced about 46 per cent of the ore directly smelted and was followed by Utah, Tennessee, Colorado, Montana, Nevada, New Mexico, and Idaho. Utah and Arizona produced 62 per cent of the silver recovered from crude ore smelted.

The old materials, principally tailings and slags, re-treated (with which are included ore and tailings leached) are partly smelted, often for their fluxing as well as their metal value; but considerable quantities of old tailings are now concentrated and cyanided, and the impounding of mill tailings for future treatment as well as because

of legal requirements has become a general practice. Owing to the low price of base metals there was less old slag and tailings treated in 1922 than in 1920 but more than in 1921. Most of the gold and silver derived from the old tailings is included under recoveries by amalgamation and cyanidation at gold and silver mills. The total quantity of ore leached in 1922 was 1,478,952 short tons, of which 1,356,230 tons came from Arizona mines, 117,712 from Utah mines, and 5,010 tons from Montana mines. The ore and old tailings leached in 1921 amounted to 1,314,810 tons.

*Gold and silver produced at mills in United States and percentage of gold and silver recovered by smelting and from placers, 1911–1922.*[a]

| Year. | Ore and tailings treated (short tons). | Bullion recovered (fine ounces). | | | | | |
|---|---|---|---|---|---|---|---|
| | | Amalgamation. | | Cyanidation. | | Chlorination. | |
| | | Gold. | Silver. | Gold. | Silver. | Gold. | Silver. |
| 1911 | 9,670,483 | 1,120,344 | 941,155 | 1,259,400 | 8,781,552 | 181,206 | 19,000 |
| 1912 | 9,677,360 | 1,003,470 | 795,755 | 1,386,526 | 11,728,730 | 16,420 | 2,500 |
| 1913 | 9,401,856 | 927,572 | 428,844 | 1,348,322 | 14,090,407 | 11,426 | 54 |
| 1914 | 9,849,085 | 924,253 | 271,417 | 1,384,935 | 15,399,836 | 23,488 | 2,530 |
| 1915 | 11,878,287 | 1,084,034 | 382,459 | 1,444,077 | 16,184,924 | 25,081 | 3,749 |
| 1916 | 11,393,838 | 964,589 | 348,177 | 1,260,172 | 14,432,378 | 20,346 | 2,784 |
| 1917 | 11,076,211 | 828,681 | 288,791 | 1,169,478 | 11,535,747 | 9,102 | 283 |
| 1918 | 8,524,496 | 678,359 | 216,670 | 1,047,186 | 9,736,605 | 5,770 | 3,631 |
| 1919 | 8,668,507 | 839,761 | 279,793 | 685,330 | 7,163,726 | ..... | ..... |
| 1920 | 7,560,043 | 679,409 | 228,807 | 580,205 | 7,582,358 | ..... | ..... |
| 1921 | [c] 7,429,125 | 765,397 | 207,877 | 559,352 | [c] 7,414,275 | ..... | ..... |
| 1922 | 7,442,998 | 812,396 | 183,119 | 541,318 | 8,803,787 | ..... | ..... |
| Total[d] | 112,572,289 | 10,628,265 | 4,572,864 | 12,666,301 | 132,854,325 | 292,839 | 34,531 |

| Year. | Percentage of gold and silver from all sources in United States. | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|
| | Amalgamation. | | Cyanidation. | | Chlorination. | | Placers. | | Smelting.[b] | |
| | Gold. | Silver. | Gold. | Silver. | Gold. | Silver. | Gold. | Silver. | Gold. | Silver. |
| 1911 | 23.9 | 1.5 | 26.1 | 14.2 | 3.8 | ..... | 24.2 | 0.3 | 22.0 | 84.0 |
| 1912 | 22.3 | 1.2 | 30.9 | 17.8 | .4 | ..... | 24.8 | .2 | 21.6 | 80.8 |
| 1913 | 21.5 | .6 | 31.2 | 19.7 | .3 | ..... | 24.9 | .2 | 22.1 | 79.5 |
| 1914 | 20.9 | .4 | 31.4 | 22.1 | .4 | ..... | 25.2 | .2 | 22.1 | 77.3 |
| 1915 | 22.8 | .4 | 30.4 | 22.1 | .5 | ..... | 22.7 | .2 | 23.6 | 77.3 |
| 1916 | 21.5 | .4 | 28.1 | 18.3 | .5 | ..... | 25.0 | .2 | 24.9 | 81.1 |
| 1917 | 20.9 | .4 | 29.5 | 16.3 | .2 | ..... | 25.8 | .2 | 23.6 | 83.1 |
| 1918 | 20.7 | .3 | 32.0 | 14.3 | .2 | ..... | 23.6 | .13 | 23.5 | 85.3 |
| 1919 | 31.5 | .5 | 28.5 | 13.8 | ..... | ..... | 25.6 | .15 | 14.4 | 85.5 |
| 1920 | 28.5 | .4 | 24.3 | 13.4 | ..... | ..... | 25.3 | .13 | 21.9 | 86.1 |
| 1921 | 32.6 | .45 | 23.9 | [c] 16.0 | ..... | ..... | 28.9 | .18 | 14.6 | [c] 83.4 |
| 1922 | 35.4 | .3 | 23.6 | 14.4 | ..... | ..... | 23.5 | .1 | 17.5 | 85.2 |
| Total[d] | 24.2 | .6 | 28.8 | 17.2 | .7 | ..... | 24.9 | .2 | 21.4 | 82.0 |

[a] Philippine Islands and Porto Rico excluded.
[b] Both crude ore and concentrates.
[c] Revised figures.
[d] Part of ore in some States (mainly South Dakota and Colorado) amalgamated, followed by cyanidation of slimes and sands.

The dredges produced $2,846,300 less gold in 1922 than in 1921, and the combined placer yield from hydraulic, drift, and other surface mines was $37,952 less than in 1921. The decrease in gold from placers was largely due to a decrease of 128,434 ounces in California, 7,516 ounces in Montana, 6,414 ounces in Oregon, and

5,965 ounces in Nevada. The percentage of the output of silver credited to the placers is insignificant.

In the mills the proportion of gold recovered by the amalgamation process increased from 32.6 per cent in 1921 to 35.4 per cent in 1922. The proportion of gold recovered by cyanidation was 23.6 per cent in 1922 compared with 23.9 per cent in 1921, 24.3 per cent in 1920, and 28.5 per cent in 1919. Colorado, Nevada, Arizona, and South Dakota ores yielded the larger part of the gold recovered by cyanidation, and the decrease was due to smaller recoveries by the cyanide process in Arizona, South Dakota, and Montana. The chlorination process has not been used in California since 1918.

## GOLD AND SILVER PRODUCED AT MILLS, BY STATES.

A large quantity of concentrates from sulphide ores is now smelted, and the increased application of the flotation process has resulted in decreased yield of gold and silver from cyanidation, as nearly all such concentrates are shipped to smelters.

The smelters, which have for two years been producing a slightly less proportion of gold and silver, are to be credited in 1922 with 17.5 per cent of the total output of gold and 85.2 per cent of the silver.

The bulk of the gold produced continues to come from the gold mills. As shown in the table, the proportion of gold recovered by amalgamation and cyanidation has increased from 49.6 per cent in 1916 to 59 per cent in 1922.

*Gold and silver bullion produced at mills in 1922, by States.*[a]

| State or Territory. | Ore and tailings treated (short tons). | Bullion recovered (fine ounces). | | | | Percentage of gold and silver from all sources in State. | | | |
|---|---|---|---|---|---|---|---|---|---|
| | | Amalgamation. | | Cyanidation. | | Amalgamation. | | Cyanidation. | |
| | | Gold. | Silver. | Gold. | Silver. | Gold. | Silver. | Gold. | Silver. |
| Alaska | 2,513,410 | 111,089 | 21,887 | 15,910 | 2,064 | 30.9 | 3.0 | 4.4 | 0.3 |
| Arizona | 191,254 | 641 | 291 | 101,612 | 151,837 | .4 | .01 | 59.6 | 3.4 |
| California | [b] 945,257 | 351,105 | 60,303 | 42,444 | 38,544 | 49.5 | 1.9 | 6.0 | 1.2 |
| Colorado [c] | 849,261 | 91,495 | 24,256 | 126,054 | 17,149 | 29.7 | .4 | 40.9 | .3 |
| Idaho | 21,662 | 7,311 | 2,394 | 1,333 | 1,956 | 30.1 | .04 | 5.5 | .03 |
| Montana | 157,444 | 6,358 | 2,425 | 21,562 | 91,547 | 7.9 | .02 | 26.9 | .73 |
| Nevada | 843,900 | 14,509 | 10,833 | 120,636 | 7,448,013 | 9.1 | .13 | 75.6 | 86.4 |
| New Mexico | 54,512 | 4,941 | 1,055 | 5,585 | 261,608 | 24.7 | .14 | 28.0 | 34.8 |
| Oregon | 2,705 | 1,910 | 589 | 387 | 50 | 7.4 | .4 | 1.5 | .03 |
| South Dakota | [d] 1,751,454 | 218,248 | 58,806 | 96,962 | 59,947 | 69.2 | 49.5 | 30.8 | 50.5 |
| Texas | 69,300 | ..... | ..... | ..... | 642,435 | ..... | ..... | ..... | 99.6 |
| Utah | 33,247 | ..... | ..... | 8,830 | 85,739 | ..... | ..... | 7.9 | .5 |
| Washington | 9,127 | 4,639 | 259 | 3 | 2,898 | 51.3 | .13 | .03 | 1.4 |
| Eastern and Appalachian States | 465 | 150 | 21 | ..... | ..... | 24.2 | .03 | ..... | ..... |
| | 7,442,998 | 812,396 | 183,119 | 541,318 | 8,803,787 | 35.4 | .3 | 23.6 | 14.4 |
| Value | ..... | $16,793,716 | $183,119 | $11,190,036 | $8,803,787 | ..... | ..... | ..... | ..... |
| 1921: Total | [e] 7,429,125 | 765,397 | 207,877 | 559,352 | [e] 7,414,275 | 32.6 | .45 | 23.9 | [e] 16.0 |
| Value | ..... | $15,822,160 | $207,877 | $11,562,832 | [e] $7,414,275 | ..... | ..... | ..... | ..... |

[a] Philippine Islands excluded.
[b] Includes 9,125 tons of concentrates cyanided, containing 21,069 ounces of gold and 6,094 ounces of silver.
[c] Part of ore amalgamated, followed by cyanidation of slimes and sands.
[d] Also 1,620,699 tons of sands and slimes from ore amalgamated was cyanided.
[e] Revised figures.

The great bulk of the ore treated was milled in Alaska, South Dakota, California, Colorado, Nevada, and Arizona, and here the famous mines and mills of the Homestake, Mother Lode, Grass Valley, Treadwell, Cripple Creek, Tonopah, Goldfield, and San Francisco (Oatman) districts are especially noteworthy. Large numbers of smaller mills, however, mark the wide distribution of gold mining in these regions and in many other scattered districts.

The total yield of gold by amalgamation in the United States in 1922 was 812,396 fine ounces, against 765,397 fine ounces in 1921, and there has been a decrease of about 152,200 ounces since 1916. Appreciable increases in 1922 were shown in California, Montana, South Dakota, New Mexico, Washington, and Nevada, and there were decreases in Alaska, Idaho, Oregon, Colorado, and Arizona.

The silver produced by amalgamation came mainly from California, South Dakota, Colorado, Alaska, and Nevada and consisted chiefly of silver alloyed with gold.

The output of gold by cyanidation decreased about 18,000 ounces. It was derived mainly from Colorado, Nevada, Arizona, and South Dakota. The principal decreases were in Alaska, 6,325 ounces; Arizona, 10,745 ounces; Montana, 5,398 ounces; and South Dakota, 8,398 ounces. There were increases in California, Colorado, Nevada, New Mexico, Utah, and Washington.

Nevada led in yield of silver by cyanidation and was followed by Texas, New Mexico, and Arizona. The most notable gains were in Nevada, 1,190,011 ounces, and Texas, 125,669 ounces.

Of the gold-producing States whose output is derived chiefly from milling ores, Alaska, California, Idaho, and South Dakota still yield more gold by amalgamation than by cyanidation, but cyanidation produces more gold than amalgamation in Arizona, Colorado, Montana, Nevada, New Mexico, and Utah, and it produces much more silver in Arizona, Montana, Nevada, New Mexico, Texas, and Utah. Only in Alaska, California, Colorado, Idaho, and Oregon did the recovery of silver by amalgamation exceed that by cyanidation. Altogether amalgamation produced gold and silver valued at $16,976,835 from milling ores in 1922, against $19,993,823 produced by cyanidation.

### QUICKSILVER AND POTASSIUM AND SODIUM CYANIDE CONSUMED IN CERTAIN STATES.

For details of the consumption of quicksilver in the amalgamation milling process and of potassium cyanide and sodium cyanide in the cyanidation process the reader is referred to the mine reports of the several Western States. The consumption of quicksilver at mills treating ore, in dredging, and in other methods of placer mining is given in the separate chapters on quicksilver in Mineral Resources for 1917–1919.

The following tables were compiled by V. C. Heikes:

*Quicksilver consumed at mills in certain Western States, 1916–1922.*

| State and year. | Number of mills using quicksilver. | Ore and tailings treated (short tons). | Quicksilver consumed (pounds).[a] | |
|---|---|---|---|---|
| | | | Total. | Per ounce of gold and silver bullion. |
| Arizona: | | | | |
| 1916 | 13 | 17,568 | 645 | 0.040 |
| 1917 | 9 | 21,100 | 205 | .057 |
| 1918 | 7 | 1,389 | 17 | .012 |
| 1919 | 6 | 2,374 | 33 | .077 |
| 1920 | 4 | 1,688 | 56 | .031 |
| 1921 | 9 | 1,215 | 68 | .066 |
| 1922 | 17 | 2,375 | 48 | .052 |
| Idaho: | | | | |
| 1916 | 36 | 66,304 | 1,183 | .039 |
| 1917 | 27 | 63,884 | 1,035 | .032 |
| 1918 | 22 | 31,263 | 953 | .057 |
| 1919 | 12 | 40,504 | 828 | .0406 |
| 1920 | 9 | 38,556 | 737 | .053 |
| 1921 | 14 | 44,545 | 355 | .025 |
| 1922 | 13 | 21,523 | 411 | .042 |
| Montana: | | | | |
| 1916 | 18 | 18,959 | 206 | .026 |
| 1917 | 13 | 8,925 | 167 | .040 |
| 1918 | 13 | 6,492 | 99 | .053 |
| 1919 | 17 | 13,142 | 178 | .054 |
| 1920 | 11 | 27,989 | 250 | .046 |
| 1921 | 13 | 2,562 | 47 | .0225 |
| 1922 | 9 | 43,757 | 218 | .025 |
| Nevada: | | | | |
| 1916 | 36 | 131,891 | 2,111 | .034 |
| 1917 | 32 | 67,359 | 839 | .020 |
| 1918 | 34 | 54,048 | 675 | .017 |
| 1919 | 21 | 60,038 | 1,149 | .026 |
| 1920 | 21 | 41,700 | 631 | .021 |
| 1921 | 23 | 13,143 | 224 | .009 |
| 1922 | 22 | 10,875 | 522 | .021 |
| Utah: | | | | |
| 1916 | 4 | 703 | 15 | .039 |
| 1917 | 2 | 190 | 5 | .030 |
| 1918 | 2 | 112 | 2 | .018 |
| Washington: | | | | |
| 1916 | 5 | 11,495 | 317 | .027 |
| 1917 | 4 | 10,976 | 185 | .026 |
| 1918 | 1 | 960 | 20 | .038 |
| 1921 | 3 | 2,930 | 227 | .126 |
| 1922 | 1 | 8,886 | 75 | .015 |

| State. | 1916 | 1917 | 1918 | 1919 | 1920 | 1921 | 1922 |
|---|---|---|---|---|---|---|---|
| | *Pounds.* | *Pounds.* | *Pounds.* | *Pounds.* | *Pounds.* | *Pounds.* | *Pounds.* |
| Arizona | 645 | 205 | 17 | 33 | 56 | 68 | 48 |
| Idaho | 1,183 | 1,035 | 953 | 828 | 737 | 355 | 411 |
| Montana | 206 | 167 | 99 | 178 | 250 | 47 | 218 |
| Nevada | 2,111 | 839 | 675 | 1,149 | 631 | 224 | 522 |
| Utah | 15 | 5 | 2 | ..... | ..... | ..... | ..... |
| Washington | 317 | 185 | 20 | ..... | ..... | 227 | 75 |
| | 4,477 | 2,436 | 1,766 | 2,188 | 1,674 | 921 | 1,274 |

[a] Partly estimated.

Quicksilver consumed at mills in Colorado in 1922 amounted to 4,711 pounds, in New Mexico to 270 pounds, and in South Dakota to 7,500 pounds.

Dredges in California used about 7,000 pounds of quicksilver in 1922. The quicksilver used by other placers and at deep mines is estimated at 4,000 pounds, making a total of 11,000 pounds for California.

*Sodium cyanide consumed at mills in certain Western States, 1916–1922, in pounds.*[a]

| State. | 1916 | 1917 | 1918 | 1919 | 1920 | 1921 | 1922 |
|---|---|---|---|---|---|---|---|
| Arizona | 216,841 | 157,381 | 157,204 | 99,605 | 219,569 | 293,597 | 259,506 |
| Colorado | 1,082,617 | 746,428 | 779,741 | 582,547 | 338,763 | 360,000 | 301,794 |
| Idaho | 700 | 3,728 | 15,600 | 950 | 1,600 | 11,391 | 4,701 |
| Montana | 190,249 | 158,215 | 83,542 | 64,900 | 105,874 | 108,665 | 291,910 |
| Nevada | 2,179,995 | 1,925,038 | 1,765,010 | 992,840 | 1,672,190 | 1,107,830 | 1,831,592 |
| New Mexico | 176,525 | 123,500 | 79,065 | 108,805 | 90,200 | 80,768 | 64,544 |
| South Dakota | 419,210 | 384,938 | 370,218 | 284,653 | [b] 365,095 | [b] 672,224 | [b] 387,683 |
| Texas | 45,100 | 37,000 | 63,130 | 38,700 | 36,976 | 43,028 | 74,428 |
| Utah | ..... | 37,000 | 2,700 | 37,844 | 40,599 | 93,200 | 118,103 |
| Washington | 2,380 | ..... | ..... | ..... | ..... | 100 | ..... |
| | 4,313,617 | 3,573,228 | 3,316,210 | 2,210,844 | [b] 2,870,866 | [b] 2,770,503 | [b] 3,334,261 |

[a] The consumption of potassium cyanide was 185,764 pounds in 1916, 137,658 pounds in 1917, 625 pounds in 1918, 68,155 pounds in 1919 (17,884 pounds at mills in Arizona and 50,271 pounds at mills in Nevada), 7,825 pounds in 1920 (7,800 pounds at mills in Arizona and 25 pounds at mills in Washington), 5,626 pounds in 1921 (Arizona, 4,200 pounds, Idaho, 600 pounds, and South Dakota, 826 pounds), and 6,610 pounds in 1922 (Arizona, 3,550 pounds, Idaho, 800 pounds, Montana, 1,030 pounds, Nevada, 230 pounds, Washington, 1,000 pounds).

[b] Includes some cyanamid in 1920 to 1922, which is reduced to the equivalent of 96 per cent NaCn.

*Potassium and sodium cyanide consumed at mills in certain Western States, 1916–1922.*

| State and year. | Number of mills using cyanidation process. | Ore and tailings treated (short tons). | Cyanide consumed (pounds).[a] | | |
|---|---|---|---|---|---|
| | | | Total. | Per ton of ore and tailings. | Per ounce of gold and silver. |
| Arizona: | | | | | |
| 1916 | 9 | 276,623 | 216,841 | 0.78 | 0.30 |
| 1917 | 10 | 227,648 | 157,961 | .69 | .43 |
| 1918 | 10 | 221,508 | 157,829 | .71 | .53 |
| 1919 | 8 | 211,199 | 117,489 | .56 | .49 |
| 1920 | 4 | 206,847 | 227,369 | 1.10 | .85 |
| 1921 | 9 | 193,414 | 297,797 | 1.54 | .21 |
| 1922 | 12 | 188,879 | 263,056 | 1.39 | 1.04 |
| Idaho: | | | | | |
| 1916 | 8 | 3,469 | 4,631 | 1.33 | .38 |
| 1917 | 4 | 3,793 | 4,996 | 1.30 | .45 |
| 1918 | 4 | 9,582 | 15,600 | 1.63 | 4.45 |
| 1919 | 3 | 907 | 950 | 1.05 | 2.07 |
| 1920 | 1 | 334 | 1,600 | 4.79 | 2.70 |
| 1921 | 4 | 2,658 | 11,991 | 4.51 | 2.12 |
| 1922 | 3 | 139 | 5,501 | ..... | 1.68 |
| Montana: | | | | | |
| 1916 | 18 | 381,560 | 203,554 | .53 | .69 |
| 1917 | 15 | 328,685 | 158,215 | .48 | .53 |
| 1918 | 14 | 190,119 | 83,542 | .44 | .53 |
| 1919 | 11 | 97,802 | 64,900 | .66 | .55 |
| 1920 | 8 | 60,999 | 105,874 | 1.74 | 1.84 |
| 1921 | 12 | 73,437 | 108,665 | 1.48 | 1.81 |
| 1922 | 14 | 113,687 | 292,940 | 2.58 | 2.59 |
| Nevada: | | | | | |
| 1916 | 33 | 1,367,249 | 2,320,328 | 1.70 | .20 |
| 1917 | 32 | 1,203,665 | 1,925,168 | 1.60 | .20 |
| 1918 | 33 | 1,220,879 | 1,765,010 | 1.45 | .21 |
| 1919 | 30 | 614,190 | 1,043,111 | 1.70 | .18 |
| 1920 | 33 | 640,690 | 1,672,190 | 2.61 | .26 |
| 1921 | 19 | 617,790 | 1,107,530 | 1.79 | .17 |
| 1922 | 28 | 833,025 | 1,831,822 | 2.20 | .24 |
| Utah: | | | | | |
| 1916 | 2 | 720 | 1,200 | 1.67 | 4.48 |
| 1918 | 1 | 900 | 2,700 | 3.00 | .63 |
| 1919 | 1 | 14,571 | 37,844 | 2.60 | .57 |
| 1920 | 1 | 23,682 | 40,599 | 1.71 | .32 |
| 1921 | 1 | 33,616 | 93,200 | 2.77 | .74 |
| 1922 | 1 | 33,247 | 118,103 | 3.55 | 1.25 |
| Washington: | | | | | |
| 1916 | 1 | 1,207 | 2,380 | 1.97 | 3.12 |
| 1920 | 1 | 8 | 25 | 3.13 | 1.04 |
| 1921 | 1 | 30 | 100 | 3.33 | .19 |
| 1922 | 1 | 241 | 1,000 | 4.15 | .34 |

[a] Partly estimated.

An investigation of the comparative solvent power of potassium cyanide, sodium cyanide, and calcium cyanide has been undertaken by the United States Bureau of Mines. Mill tests on various ores that are typical of certain districts are being made for operators.

It has not been possible to obtain figures showing the total quantity of potassium cyanide and sodium cyanide used in the recovery of gold and silver in the United States in 1922. If the estimated quantities used in California, 260,000 pounds, Alaska, 5,000 pounds, and Oregon, 15,000 pounds, are added to the 3,340,871 pounds reported to have been used in other Western States, the total consumption was probably about 3,600,000 pounds.

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# GOLD, SILVER, COPPER, AND LEAD IN ALASKA.[1]

(MINES REPORT.)

By Alfred H. Brooks and S. R. Capps.

## PRODUCTION.

The following table gives an estimate of the total production of gold, silver, copper, and lead in Alaska to the end of 1922:

*Gold, silver, copper, and lead produced in Alaska, 1880–1922.*

| Year. | Gold. | | Silver. | | Copper. | | Lead. | |
|---|---|---|---|---|---|---|---|---|
| | Fine ounces. | Value. | Fine ounces. | Commercial value. | Pounds. | Value. | Short tons. | Value. |
| 1880–1915 | 12,619,051 | $260,858,943 | 4,923,198 | $2,821,911 | [a]220,777,902 | [a]$35,032,051 | 1,261 | $109,604 |
| 1916 | 834,068 | 17,241,713 | 1,379,171 | 907,495 | 119,854,839 | 29,484,291 | 820 | 113,160 |
| 1917 | 709,049 | 14,657,353 | 1,239,150 | 1,021,060 | 88,793,400 | 24,240,598 | 852 | 146,584 |
| 1918 | 458,641 | 9,480,952 | 847,789 | 847,789 | 69,224,951 | 17,098,563 | 564 | 80,088 |
| 1919 | 455,984 | 9,426,032 | 629,708 | 705,273 | 47,220,771 | 8,783,063 | 687 | 72,822 |
| 1920 | 404,683 | 8,365,560 | 953,546 | 1,039,364 | 70,435,363 | 12,960,106 | 875 | 140,000 |
| 1921 | 390,558 | 8,073,540 | 761,085 | 761,085 | 57,011,597 | 7,354,496 | 759 | 68,279 |
| 1922 | 359,057 | 7,422,367 | 729,945 | 729,945 | 77,967,819 | 10,525,655 | 377 | 41,477 |
| | 16,231,091 | 335,526,460 | 11,463,592 | 8,833,922 | 751,286,642 | 145,478,823 | 6,195 | 772,014 |

[a] Revised figures.

The mining industry of Alaska showed signs in 1922 of recovery from the depression it experienced in 1921. Although there was further decline in the gold production below the figures for 1921, this decrease was more than offset by the increase in the production of copper. The total value of the gold, silver, copper, and lead produced in Alaska in 1922 was $18,719,444, against $16,257,400 in 1921. The output of the gold placers increased slightly, and that of the gold lodes decreased.

## GOLD AND SILVER.

The subjoined table gives an estimate, based on the best available data, of the gold and silver produced in Alaska from different sources since mining began in 1880. About $65,900,000 worth of gold, or about one-fifth of the total estimated output, was produced before 1905, and there is but scant information as to its source. For the period since that time fairly complete statistical returns are avail-

[1] The data on mining conditions and production here given are abstracted from a paper published in U. S. Geol. Survey Bulletin 755. The authors were assisted in the statistical work by T. R. Burch. The original paper and the papers that accompany it treat the subject at greater length than is desired here, and they should be consulted by those who require the more detailed information.

able, and it is probable that the figures presented in the following table are sufficiently accurate to be valuable. The figures given for the silver recovered from placer gold and from siliceous ores are probably less accurate than those for the gold. A little copper mining was done at Kasaan Bay, in the Ketchikan district, as early as 1880, but this project was soon abandoned. About 1899 the copper deposits of Ketchikan and Prince William Sound began to receive attention, and in 1900 small shipments began. The figures for gold and silver derived from this industry, as now presented, are a close approximation to the actual output.

*Gold and silver produced in Alaska from different sources, 1880–1922.*

| Source. | Gold. | | Silver. | |
|---|---|---|---|---|
| | Fine ounces. | Value. | Fine ounces. | Value. |
| Siliceous ores [a] | 4,993,458 | $103,223,966 | 1,948,221 | $1,594,937 |
| Copper ores | 86,857 | 1,795,502 | 7,666,666 | 6,125,581 |
| Placers | 11,150,776 | 230,506,992 | 1,848,705 | 1,113,404 |
| | 16,231,091 | 335,526,460 | 11,463,592 | 8,833,922 |

[a] Including small amounts of galena ore.

*Gold and silver produced in Alaska, 1922, by sources.*

| Source. | Gold. | | Silver. | |
|---|---|---|---|---|
| | Fine ounces. | Value. | Fine ounces. | Value. |
| Siliceous ores (2,513,455 short tons) | 145,716 | $3,012,211 | 71,346 | $71,346 |
| Copper ores (581,384 short tons) | 729 | 15,064 | 623,518 | 623,518 |
| Lead ores (79 short tons) | 4 | 92 | 8,712 | 8,712 |
| Placers (5,226,000 cubic yards of gravel) | 212,608 | 4,395,000 | 26,369 | 26,369 |
| | 359,057 | 7,422,367 | 729,945 | 729,945 |

## LODE MINING.

Twenty-five gold and silver lode mines, six prospects,[2] and a few small mines producing lead ores were operated in 1922 and produced gold, silver, and some lead and copper to a total value of $3,133,884; in 1921 19 gold and silver lode mines and 13 prospects were operated and produced metals to a total value of $4,082,741. A large decreaes in output was recorded for southeastern Alaska, but this was partly offset by increases in production in the Willow Creek and Fairbanks districts and by a considerable output from a new mine in the Kuskokwim basin.

[2] Lode properties the value of whose metallic output is less than $1,000 are here classed as prospects. These include some mines on which considerable development work has been done but which have not yet been put on a regular productive basis.

*Gold and silver produced from gold and silver lode mines and prospects in Alaska in 1922, by districts.*

| District. | Ore mined (short tons). | Gold. | | Silver. | | Average value per ton of ore in gold and silver. |
|---|---|---|---|---|---|---|
| | | Fine ounces. | Value. | Fine ounces. | Value. | |
| Southeastern Alaska | 2,501,538 | 124,795.60 | $2,579,754 | 67,511 | $67,511 | $1.06 |
| Willow Creek | 7,242 | 11,513.25 | 238,000 | 1,500 | 1,500 | 33.07 |
| Fairbanks | 1,724 | 2,612.25 | 54,000 | 490 | 490 | 31.61 |
| Other districts | 2,951 | 6,794.60 | 140,457 | 1,845 | 1,845 | 48.22 |
| | 2,513,455 | 145,715.70 | 3,012,211 | 71,346 | 71,346 | 1.23 |

## PLACER MINING.

During 43 years of mining Alaska has produced gold to the value of $335,526,460, and of this amount $230,506,992 is to be credited to her placer mines. More placer mining was done in 1922 than in 1921, and a gradual revival in this industry is taking place. Several new dredges were installed, and a number of large hydraulic operations were started. The completion of the Government railroad from the coast to Fairbanks has already decreased transportation costs, and mining in the region tributary to the railroad has already responded to this stimulus. Alaska possesses enormous reserves of alluvial gold that will eventually be mined by quantity methods with their low cost of operation.

There was an increase of 4 per cent in the value of the output of placer gold in 1922 as compared with 1921. The chief gain was in the Yukon camps, where the increase was 14 per cent. The greatest percentage of increase was in the Cook Inlet and Susitna region, where the successful operation of a dredge in the Cache Creek (Yentna) district added materially to the regional output. The record of 507 placer mines operated in the summer of 1922 and 120 in the previous winter somewhat exaggerates the activity of the industry. These totals, like those given in all previous reports, include every placer-mine operation of the year, no matter how small, and among them are many whose output for the year amounted to only a few hundred dollars.

*Gold and silver produced from placer mines in Alaska in 1922, by regions.*

| Region. | Gold. | | Silver. | | Gravel mined (cubic yards). | Value of gold recovered per cubic yard. |
|---|---|---|---|---|---|---|
| | Fine ounces. | Value. | Fine ounces. | Value. | | |
| Southeastern Alaska | 145.13 | $3,000 | 23 | $23 | 1,800 | $1.67 |
| Copper River region | 7,981.88 | 165,000 | 851 | 851 | 305,747 | .54 |
| Cook Inlet and Susitna region | 14,173.88 | 293,000 | 2,095 | 2,095 | 593,788 | .49 |
| Yukon basin | 102,506.62 | 2,119,000 | 13,751 | 13,751 | 1,999,167 | 1.06 |
| Kuskokwim region | 26,219.25 | 542,000 | 2,815 | 2,815 | 215,950 | 2.51 |
| Seward Peninsula | 61,194.37 | 1,265,000 | 6,790 | 6,790 | 2,103,691 | .60 |
| Kobuk region | 387.00 | 8,000 | 44 | 44 | 5,857 | 1.37 |
| | 212,608.13 | 4,395,000 | 26,369 | 26,369 | 5,226,000 | .84 |

The following table is based in part on returns made by operators of placer mines and in part on known facts or assumptions concerning the richness of the gravel in the several districts. Although the table is thus in part an estimate, it is probably nearly correct.

*Gravel sluiced in Alaskan placer mines and value of gold recovered, 1908–1922.*

| Year. | Total quantity of gravel (cubic yards). | Value of gold recovered per cubic yard. | Year. | Total quantity of gravel (cubic yards). | Value of gold recovered per cubic yard. |
|---|---|---|---|---|---|
| 1908 | 4,275,000 | $3.74 | 1916 | 7,100,000 | $1.57 |
| 1909 | 4,418,000 | 3.66 | 1917 | 7,000,000 | 1.40 |
| 1910 | 4,036,000 | 2.97 | 1918 | 4,931,000 | 1.20 |
| 1911 | 5,790,000 | 2.17 | 1919 | 4,548,000 | 1.10 |
| 1912 | 7,050,000 | 1.70 | 1920 | 3,439,900 | 1.13 |
| 1913 | 6,800,000 | 1.57 | 1921 | 4,812,700 | .88 |
| 1914 | 8,500,000 | 1.26 | 1922 | 5,226,000 | .84 |
| 1915 | 8,100,000 | 1.29 | | | |

*Relation of recovery of placer gold per cubic yard to proportion produced by dredges, 1911–1922.*

| Year. | Percentage of placer gold produced by dredges. | Recovery per cubic yard. | | | Year. | Percentage of placer gold produced by dredges. | Recovery per cubic yard. | | |
|---|---|---|---|---|---|---|---|---|---|
| | | Dredges. | Mines. | All placers. | | | Dredges. | Mines. | All placers. |
| 1911 | 12 | $0.60 | $3.36 | $2.17 | 1917 | 26 | $0.68 | $2.21 | $1.40 |
| 1912 | 18 | .65 | 2.68 | 1.70 | 1918 | 24 | .57 | 1.84 | 1.20 |
| 1913 | 21 | .54 | 3.11 | 1.57 | 1919 | 27 | .77 | 1.31 | 1.10 |
| 1914 | 22 | .53 | 2.07 | 1.26 | 1920 | 29 | .69 | 1.53 | 1.13 |
| 1915 | 22 | .51 | 2.33 | 1.29 | 1921 | 37 | .57 | 1.31 | .88 |
| 1916 | 24 | .69 | 2.64 | 1.57 | 1922 | 40 | .55 | 1.29 | .84 |

The 23 dredges operated in 1922 employed crews numbering 325 men. Two of these dredges were in the Fairbanks district, two in the Iditarod, one each in the Innoko, Mount McKinley (McGrath), Circle, and Yentna districts, and fifteen in Seward Peninsula. The average gold recovery of the eight Yukon, Kuskokwim, and Yentna dredges was about 72 cents to the cubic yard, and that of the Seward Peninsula dredges was about 39 cents to the cubic yard. The inland dredges were operated for an average of 140 days, and the longest season was that in the Iditarod district, 163 days. The dredges on Seward Peninsula were operated for an average of 70 days, and the longest season for any one dredge was 114 days.

*Gold produced by dredge mining in Alaska, 1903–1922.*

| Year. | Number of dredges operated. | Value of gold output. | Gravel handled (cubic yards). | Value of gold recovered per cubic yard. |
|---|---|---|---|---|
| 1903 | 2 | $20,000 | | |
| 1904 | 3 | 25,000 | | |
| 1905 | 3 | 40,000 | | |
| 1906 | 3 | 120,000 | [a] | [a] |
| 1907 | 4 | 250,000 | | |
| 1908 | 4 | 171,000 | | |
| 1909 | 14 | 425,000 | | |
| 1910 | 18 | 800,000 | | |
| 1911 | 27 | 1,500,000 | 2,500,000 | $0.60 |
| 1912 | 38 | 2,200,000 | 3,400,000 | .65 |
| 1913 | 35 | 2,200,000 | 4,100,000 | .54 |
| 1914 | 42 | 2,350,000 | 4,450,000 | .53 |
| 1915 | 35 | 2,330,000 | 4,600,000 | .51 |
| 1916 | 34 | 2,679,000 | 3,900,000 | .69 |
| 1917 | 36 | 2,500,000 | 2,700,000 | .68 |
| 1918 | 28 | 1,425,000 | 2,490,000 | .57 |
| 1919 | 28 | 1,360,000 | 1,760,000 | .77 |
| 1920 | 22 | 1,129,932 | 1,633,861 | .69 |
| 1921 | 24 | 1,582,520 | 2,799,519 | .57 |
| 1922 | 23 | 1,767,753 | 3,186,343 | .55 |
| | | 24,875,205 | | |

[a] Data not available.

## COPPER.

The large increase in the output of copper, shown below, is to be credited almost entirely to the three mines of the Kennecott group, in the Chitina basin, and the Beatson mine, on Prince William Sound. Five copper mines were operated productively in 1922, as compared with six in 1921.

*Copper produced in Alaska, 1880-1922.*

| Year. | Copper mines operated. | Copper ore treated or shipped (short tons). | Copper produced.[a] | |
|---|---|---|---|---|
| | | | Pounds. | Value. |
| 1880 | 1 | [b]20 | 3,933 | $826 |
| 1900 | [b]1 | [b]500 | [b]100,000 | [b]16,000 |
| 1901 | 2 | [b]1,350 | [b]270,000 | [b]44,000 |
| 1902 | 3 | [b]2,750 | [b]510,000 | [b]59,000 |
| 1903 | 4 | [b]9,000 | [b]1,730,000 | [b]224,510 |
| 1904 | 4 | [b]15,000 | [b]2,843,586 | [b]376,076 |
| 1905 | 8 | 52,199 | [b]3,481,771 | [b]542,155 |
| 1906 | [b]15 | [b]105,739 | [b]6,459,803 | [b]1,246,682 |
| 1907 | 13 | 98,927 | 6,308,786 | 1,261,757 |
| 1908 | [b]9 | 51,509 | 4,585,362 | 605,267 |
| 1909 | 7 | 34,669 | 4,124,705 | 536,211 |
| 1910 | 7 | 39,365 | 4,241,689 | 538,695 |
| 1911 | 8 | 68,975 | 27,267,878 | 3,408,485 |
| 1912 | [b]7 | 93,452 | 29,230,491 | 4,823,031 |
| 1913 | [b]6 | 135,756 | 21,659,958 | 3,357,293 |
| 1914 | 6 | 153,605 | 21,450,628 | 2,852,934 |
| 1915 | [b]14 | 369,600 | 86,509,312 | 15,139,129 |
| 1916 | 18 | 617,264 | 119,854,839 | 29,484,291 |
| 1917 | 17 | 659,957 | 88,793,400 | 24,240,598 |
| 1918 | 17 | 722,047 | 69,224,951 | 17,098,563 |
| 1919 | [b]8 | 492,644 | 47,220,771 | 8,783,063 |
| 1920 | 8 | 766,095 | 70,435,363 | 12,960,106 |
| 1921 | 6 | 477,121 | 57,011,597 | 7,354,496 |
| 1922 | 5 | 581,384 | 77,967,819 | 10,525,655 |
| | | 5,548,928 | 751,286,642 | 145,478,823 |

[a] Includes, in addition to copper from copper ore, some copper won from ores mined chiefly for other metals.
[b] Revised figures.

The average copper content of the ore mined in 1922 was 6.7 per cent. The ores yielded an average of $0.026 in gold and $1.07 in silver to the ton. The average yield in 1921 was 5.8 per cent of copper and $0.058 in gold and $1.14 in silver.

Of the total copper ore mined in Alaska in 1922, 94 per cent, or 544,212 tons, was concentrated and yielded 53,572 tons of concentrates which averaged 45 per cent copper. Most of the copper ore mined in 1922 was shipped to the Tacoma smelter, but a part of that mined in southeastern Alaska was treated elsewhere.

In 1922, as in previous years, the Rush & Brown copper mine was the largest copper producer in southeastern Alaska. Little prospecting or development work was done on the copper deposits of southeastern Alaska. The three large mines, the Bonanza, Jumbo, and Mother Lode, were the only producing mines of the Chitina district in 1922, and no considerable developments were made at other mines. Some alluvial copper was produced incidentally to gold mining in the Nizina district. On Prince William Sound the Beatson mine, at Latouche, was the only property operated systematically throughout the year. Development work was continued at the Rua copper mine, on Knight Island. A small output of copper was made from mines in the upper Kuskokwim Valley and in some other districts.

The low price of copper has prevented the owners of many small mines from renewing operations, but there was some renewal of interest in prospecting copper lodes in 1922, notably in the Chitina Valley. An advance in the price of copper will undoubtedly revivify copper-mining activities in Alaska.

## LEAD.

No marked advances were made in 1922 in the development of deposits of galena. The Moonshine property, in the Ketchikan district, long idle, was again opened up. Though the lodes of the Salmon River district (Portland Canal), which carry a high content of silver, are as yet unproductive, the outlook for profitable mining is good. In the Kantishna district the prospecting of galena ores continued with encouraging results, but systematic and large underground exploration must await the construction, already begun, of wagon roads to the Alaska Railroad. So far as now known, the Perseverance claim, in the Ruby district, and the Quigley mine, in the Kantishna district, were the only galena deposits mined in 1922. The output from these properties and the by-product from the Alaska Juneau mine appear to have been the source of the entire production of lead in Alaska in 1922. The silver produced in 1922, estimated at 729,945 ounces, was only in small part derived from these galena deposits, for most of it was a by-product of gold and copper mining. The Alaska lead output is as yet but small and in the past has fluctuated with gold and copper mining. In 1922 377 tons, valued at $41,477, was produced, as compared with 759 tons, valued at $68,279, in 1921.

# INDEX.


A.

Page.

Abrasives, bauxite 96
imports and exports 15A
production 15A
Adirondack district, N. Y., mining operations 356
Ajo district, Ariz., copper produced 279–280
Alabama, bauxite mining 90
mineral production 100A
Alaska, copper 269–270, 641–642
gold 607–608, 637–641
lead 642
mineral production 100A
silver 608, 637–639
Algeria, antimony resources 104
Aluminum, condition of the industry 93
customs duties 89, 93
imports and exports 92
market and prices 93
production and consumption 91–92
refractories 96
salts, condition of the industry 94–95
customs duties 95
production and consumption 94, 95
secondary, quantities recovered 189
American Smelting & Refining Co., operations 268–269
Antimonial lead 98, 101
Antimony, consumption 102
foreign deposits 102–105
imports and exports 99–101
market and prices 97, 102
production 98
secondary, quantity recovered 99, 186
stocks 101
uses and substitutes 97–98
world's production 102
Argentina, antimony resources 103
arsenic requirements 69–70
Arizona, copper 270–280, 489, 490–495, 497–499
gold 489, 490–495, 497–499, 608
history of mining 489–490
lead 489, 490–495, 497–499
milling operations 496–498
mineral production 101A
mining of copper 494, 495–496
gold 493, 495
lead 494–495, 496
silver 493, 495
zinc 494, 496
mining operations 496
Cochise County 500–503
Gila County 503–506
Globe district 503–506
Graham County 506
Greenlee County 506–507
Maricopa County 507
Mohave County 508–510
Pima County 510–512
Pinal County 512–514
Santa Cruz County 514–515
Yavapai County 515–518
Yuma County 518
ores, production and content 490–495
silver 489, 490–495, 497–499, 608
zinc 489, 490–492, 498, 499
Arkansas, bauxite mining 90
lead and zinc 141–143
mineral production 101A
Arsenic, demand and supply 55–56
distribution by States 60–64
foreign resources 66–72
freight rates 57–58
imports and exports 54
lead arsenate 76
manufacture of calcium arsenate 74–76
metallic, process for making 76
occurrence and development of ores 59–60
outlook for 1923 58–59
Arsenic, prices 56–57
production 53
weed killer made from 55
white 54–55
methods of recovering 72–74
world's production 64–66
Asbestos, imports 19A
production 18A
supply 18A
Asphalt and related bitumens, imports and exports 20A
production 19A
Australia, antimony resources 105
arsenic resources 72

B.

Barium products, imports 22A
production 21A
Barytes, consumption 21A
production 21A
supply 20A
Bauxite, abrasives 96
deposits 90–91
market and prices 88–89
production and consumption 87–88
supplies 22A
world's production 89
Begeman, F., with Dunlop, J. P., Silver, copper, lead, and zinc in the Central States 137–168
Bismuth, imports 24A, 15
production and sources, domestic 24A, 15–17
production and sources, foreign 17–22
uses 22
Blast furnaces in blast 368
Bolivia, antimony resources 103
Borneo, antimony resources 104
Brass, exports 302
Brazil, arsenic resources 70
Briquets (fuel), production 24A
British Africa, antimony resources 105
Bromine, imports and production 24A
Burchard, Ernest F., and Davis, Hubert W., Iron ore, pig iron, and steel 341–376

C.

Cadmium, condition of the industry 1
electroplating 1–2
imports and exports 4
lithopone, new process 3
prices 4–5
production 2–3
red-light arc lamp 3–4
Calcium arsenate, methods of making 74–76
Calcium chloride, production and imports 25A
California, copper 280–282, 405, 406–408, 416
gold 405, 406–408, 414–417, 609
lead 405, 406–408, 416
milling 411–413
mineral production 102A
mining of copper 410
gold 408–409
lead 410
platinum-metals 131–132
silver 410
zinc 411
mining operations 413–415
Amador County 417–418
Butte County 418–419
Calaveras County 419–420
Colusa County 420
Del Norte County 420
Eldorado County 420–421
Fresno County 421
Humboldt County 421
Imperial County 421–422

Page.
California, mining operations, Inyo County 422–423
mining operations, Kern County 423–424
Lassen County 424
Los Angeles County 424
Madera County 424
Mariposa County 424–425
Merced County 425
Mono County 425
Nevada County 425–426
Orange County 427
Placer County 427
Plumas County 427–429
Sacramento County 429
San Bernardino County 429–430
San Diego County 431
Shasta County 431–432
Sierra County 432–433
Siskiyou County 433–435
Stanislaus County 435
Trinity County 435–436
Tuolumne County 436–437
Yuba County 438
ores, production and content 406–408
quicksilver 118–119
silver 405, 406–408, 414–417, 609
zinc 405, 406–408, 416
Canada, antimony resources 103
arsenic resources 66–67
feldspar produced 43A
platinum metals produced 132–133
Carbon black, production 25A
Cement, production 26A–28A
shipments 27A, 28A
Central States, silver, copper, lead, and zinc 138–141
tenor of lead and zinc ores 137–138
China, antimony resources and exports 103–104
arsenic resources 71–72
Chromite, consumption 109–111
imports 30A, 108–109
prices 112
production 29A, 107
supply 29A
world's production 111
Clark, Martha B., Summary 7A–127A
Clay, imports and exports 31A
production 30A
Clay products, imports and exports 33A
production 31A–32A
Coal, imports and exports 35A
production 33A–34A
Cobalt, domestic and foreign mining 557–559
imports 35A–36A, 559
production 35A
Coke, imports and exports 38A
production 36A–37A
Coke-oven by-products, production 38A–39A
Colombia, platinum mining 133
Colorado, copper 282, 519, 521–527, 530
gold 519, 520–527, 530, 609
lead 519, 521–527, 530
mineral production 103A
mining and milling operations 527–530
mining operations, Adams County 531
Boulder County 531–532
Chaffee County 532
Clear Creek County 532–534
Conejos County 534
Custer County 534–535
Denver County 535
Dolores County 535
Douglas County 535
Eagle County 536
El Paso County 536
Fremont County 536–537
Gilpin County 537–538
Grand County 538
Gunnison County 538–539
Hinsdale County 539
Jackson County 539
Lake County 539–541
La Plata County 541
Mineral County 541
Moffat County 542
Montrose County 542
Ouray County 542–543
Park County 543–544
Pitkin County 544

Page.
Colorado, mining operations, Rio Grande County 544–545
mining operations, Routt County 545
Saguache County 545
San Juan County 545–546
San Miguel County 546–549
Summit County 549–551
Teller County 551–556
ore deposits in Costilla County 534
ores, production and tenor 519–527
silver 519, 520–527, 530, 610
zinc 519, 521, 524–527, 530
Connecticut, mineral production 103A
Copper, casting, sources 295
condition of the industry 259–260
consumption 302–303
electrolytic, classification 295
exports 299–301
imports 297–298
Lake, methods of refining 295
operations by States 269–294
operations of the American Smelting & Refining Co 268–269
ores, production 267–268
prices, 1850–1922 303–304
production, by districts 264–265
by States, 1913 and 1918–22 259, 262–264
from mines 262, 263, 264
from refineries 40A, 262, 294–296
from smelters 40A, 259, 262–264
from various ores 265–267
secondary, quantity recovered 183–184, 296–297
smelters producing 261–262
statistics, sources 257–258
summary for 1913 and 1918–22 39A, 258–259
stocks 297
uses 303
*See also* Arizona, California, Central States, Colorado, Eastern States, Idaho, Montana, Nevada, New Mexico, Oregon, Texas, Utah, Washington, and Wyoming.
Copper sulphate, exports 299
production 297
Corse, W. M., Secondary nonferrous metals 174–176
Cripple Creek district, Colo., mining operations 551–556
Cryolite, imports 42A
Cuba, arsenic resources 69
iron ore produced 359
Cuyuna range, Minn., operations 353–354

D.

Davis, Hubert W., with Burchard, Ernest F., Iron ore, pig iron, and steel 341–376
Delaware, mineral production 104A
District of Columbia, mineral production 104A
Dunlop, J. P., Gold and silver (general report) 595–635
Gold, silver, copper, lead, and zinc in the Eastern States 7–14
Secondary metals 173–191
and Begeman, F., Silver, copper, lead, and zinc in the Central States 137–168

E.

Eastern States, gold, silver, copper, lead, and zinc 7–14
Ely district, Nev., copper produced 287–289
Evans, Isabel P., Recent publications on quicksilver 121–124

F.

Feldspar, production 42A
production in Canada 43A
Ferroalloys, imports and exports 44A, 372–373
prices 44A, 372
production 43A, 371
Ferromanganese, consumption 592
imports 593
prices 593–594
producers 591
production 593
Ferromolybdenum, production and imports 562

Page.

Ferrovanadium, imports and exports 583
Finland, occurrence of platinum 133
Florida, mineral production 104A
Fluorspar, production and supply 45A
France, antimony production 102, 103

G

Gas, natural, production 46A
Gasoline, from natural gas, production 46A–47A
  treatment with diethyl telluride 25
Gems, imports and exports 48A
  production 47A
Georgia, bauxite mining 90
  gold, silver, copper, and lead 8, 9–10, 612
  mineral production 105A
Germany, arsenic resources 68
Gerry, C. N., Gold, silver, copper, lead, and zinc in Idaho 217–244
  Gold, silver, copper, lead, and zinc in Montana 453–488
  Gold, silver, copper, lead, and zinc in Washington 245–256
Gogebic range, Mich.–Wis., operations on 354
Gold, cyanides used in recovery 632–635
  consumption in industries 596
  domestic supply 599–600
  dry and siliceous ores yielding 622–625
  imports and exports 599
  mines producing 615–616
  ores produced 616–619
  placers producing 620–621
  price 605
  producers, largest 606–607
  production, at mills 631–632
    by methods of treatment 628–631
    by sources, 1905–1922 619–625
    by States 595, 605, 607–614
    from dredging 621
    increase or decrease 596
    Philippine Islands 614
    1792–1922 597
    southern Appalachian States 612
    sources of information 595–596, 604, 635
  quicksilver used in recovery 632–633
  secondary, quantity recovered 596
  world's production, 1860–1922 600–601
    curve showing 600
  *See also* Alaska, Arizona, California, Colorado, Eastern States, Idaho, Montana, Nevada, New Mexico, Oregon, South Dakota, Utah, Washington, and Wyoming.
Graphite, imports and exports 51A
  production and prices 50A–51A
Greece, arsenic resources 70
Gypsum, imports and exports 52A
  production 51A

H.

Heikes, Victor C., Bismuth, selenium, and tellurium 15–25
  Gold, silver, copper, lead, and zinc in Arizona 489–518
  Gold, silver, copper, lead, and zinc in Nevada 305–339
  Gold, silver, copper, lead, and zinc in Utah 377–403
  and Loughlin, G. F., Arsenic 53–76
Henderson, Charles W., Gold, silver, and copper in Wyoming 197–198
  Gold, silver, and lead in South Dakota 193–196
  Gold, silver, copper, lead, and zinc in Colorado 519–556
  Gold, silver, copper, lead, and zinc in New Mexico 199–213
  Silver, copper, and lead in Texas 215
Hess, Frank L., Cobalt, molybdenum, nickel, tantalum, titanium, tungsten, radium, uranium, and vanadium 557–583
Hill, James M., Bauxite and aluminum 87–96
  Gold, silver, copper, and lead in Oregon 439–451
  Gold, silver, copper, lead, and zinc in California 405–438
  Platinum and allied metals 125–135
Homestake mine, operations 194, 195–196

I.

Page.

Idaho, condition of mining 224
  copper 217, 218–222, 223–224, 282
  gold 217, 218–223, 610
  lead 217, 218–223, 224
  milling of ores 225–227
  mineral production 105A
  mining operations, Ada County 230
    Adams County 230
    Blaine County 230–231
    Boise County 231–232
    Bonner County 232
    Bonneville County 232
    Boundary County 233
    Butte County 233
    Camas County 233
    Clark County 233
    Clearwater County 233–234
    Custer County 234
    Elmore County 234–235
    Gem County 235
    Idaho County 235
    Kootenai County 235–236
    Latah County 236
    Lemhi County 236–237
    Owyhee County 237
    Power County 237
    Shoshone County 238–244
    Twin Falls County 244
    Valley County 244
    Washington County 244
  production by counties 228–229
    from placers 218, 228, 229
  ores, production and metal content 219–223
  silver 217, 218–223, 610
  trend of mining 217–218
  zinc 217, 218–223, 224
Illinois, lead and zinc 143–145
  mineral production 106A
  silver 139, 144, 610
India, antimony resources 104
  arsenic resources 72
Indiana, mineral production 106A
Indo-China, antimony resources 104
Iowa, mineral production 107A
Iridium. *See* Platinum and allied metals.
Iron, condition of the industry 341–343
  exports 376
  imports 375
  *See also* Ferroalloys, Iron ore, Pig iron, *and* Steel.
Iron ore, beneficiation 361–362
  Bulletins on deposits 343
  imports and exports 357–358
  mines producing 348–349
  mining in Cuba 359
    in the Adirondack district 356
    in the Western States 356–357
  operations in the Lake Superior district 352–355
    in the southeastern States 355
  prices 350–351, 352
  production 343–347
  stocks at Lake ports 352
    at mines 53A, 349–350
  world's production 360
Isle of Pines, gold-silver-arsenic deposit 69
Italy, antimony resources 103

J.

Japan, antimony smelting 104
  arsenic resources 68–69
  occurrences of platinum metals 133–134
Jenison, H. A. C., Copper 257–304
  and Meyer, H. M., Manganese and manganiferous ores 585–594
Johnson, Bertrand L., Tin 169–172
Jugoslavia, arsenic resources 70

K.

Kansas, lead and zinc 146–149
  mineral production 107A
Kentucky, lead and zinc 149
  mineral production 108A

L.

Labor troubles, effects on mineral production 1A, 2A–3A

Page.

Lake Superior district, iron ore produced and marketed 351–355
iron ore reserves 355
Lead, consumption 34
customs duties 34
imports and exports 31–33
prices, 1850–1922 34–36
production 56A–57A, 27–30
secondary, quantities recovered 57A, 184–185
supply 56A
tenor of ores in the Central States 137–138
world's production 30–31
*See also* Arizona, California, Central States, Colorado, Eastern States, Idaho, Montana, Nevada, New Mexico, Oregon, South Dakota, Texas, Utah, and Washington.
Lead, arsenate, methods of manufacture 76
Lead, pigments and salts, customs duties 81
imports and exports 78–80
prices 81–84
processes of making 77
producers 84–85
quantities marketed 78
sources of metal content 78
Lime, imports and exports 59A
production 58A–59A
Lithium minerals, production 60A
Lithographic stone, imports 60A
production 60A
Lithopone, cadmium, new process 3
*See also* Lead and zinc pigments and salts.
Loughlin, G. F., Introduction 1A–6A
Prefatory note to the reports on gold, silver, copper, lead, and zinc 125A–127A
with Heikes, V. C., Arsenic 53–76
Louisiana, mineral production 108A

M.

Magnesite, imports 61A
production 60A
Magnesium, imports and production 61A
Maine, mineral production 108A
Manganese, condition of the industry 585
imports 586, 590
production 62A–63A, 586–589, 590
supply 62A
Manganese ore, prices 594
Manganiferous zinc residuum 63A
Marl, production 63A–64A
Marquette range, Mich., operations 354
Maryland, mineral production 109A
Massachusetts, Chipman mine 10
mineral production 109A
Menominee range, Mich.-Wis., operations 354–355
Mercury. *See* Quicksilver.
Mesabi range, Minn., operations 352–353
Metals, summary of production 7A–8A, 11A
Mexico, antimony production 103
arsenic resources 67
Meyer, H. M., with Jenison, H. A. C., Manganese and manganiferous ores 585–594
Mica, imports and exports 64A
production 64A
Michigan, copper 150–152, 282–284
mineral production 110A
mining operations, Houghton County 150–152
Keweenaw County 152
silver 139, 150, 610
Mineral paints, production from ores 64A–65A
Mineral waters, imports and exports 65A
production 65A
Mineral Creek district, Ariz., copper produced 279
Minnesota, mineral production 110A
Mississippi, bauxite deposits 91
mineral production 111A
Missouri, aluminum-bearing clay, mining 91
copper 139, 153
lead and zinc 153–160
mineral production 111A
silver 139, 153, 159, 610
Molybdenum, uses and imports 66A, 561–562
Monel metal, requirements for scrap 190–191

Page.

Montana, concentrates, production and content 463–464
copper 284–287, 453, 454–456, 464, 465, 466
gold 453, 454–456, 463–465, 466, 467, 611
history of mining 453–454
lead 453, 454–456, 464, 465, 466
milling operations 462–464
mineral production 112A
mining of copper 461
gold 460–461
lead 462
silver 461
zinc 462
mining operations 462
Beaverhead County 468
Broadwater County 468–469
Cascade County 469–470
Deer Lodge County 470
Fergus County 471
Granite County 472–473
Jefferson County 473–475
Judith Basin County 475
Lewis and Clark County 475–477
Lincoln County 477
Madison County 477–479
Meagher County 479
Mineral County 479–480
Missoula County 480
Park County 480
Phillips County 480
Powell County 480–481
Ravalli County 481
Sanders County 481
Silver Bow County 482–488
Sweet Grass County 488
ores, production, and content 456–460
silver 453, 454–456, 463–465, 466, 467, 611
zinc 453, 454–456, 464, 466

N.

Nebraska, mineral production 112A
Nevada, condition of mining 317
copper 287–289, 305, 307–315, 318
gold 305, 307–315, 318–319, 611
history of mining 305–309
lead 305, 307–315, 318
milling 313–315
mineral production 113A
mining of copper 316
gold 315–316
lead 316–317
silver 316
zinc 317
mining operations 317
Churchill County 319
Clark County 319–320
Douglas County 320
Elko County 320–321
Esmeralda County 322–323
Eureka County 323–324
Humboldt County 324–325
Lander County 325–326
Lincoln County 326–327
Lyon County 327–328
Mineral County 328–330
Nye County 330–335
Pershing County 335–336
Storey County 336–337
Washoe County 337
White Pine County 338–339
ores, production and content 308–313
placer mines, production 307, 319
quicksilver 119
silver 305, 307–315, 318–319, 611
zinc 305, 307–315, 318
New Hampshire, mineral production 113A
New Jersey, mineral production, zinc 9, 10
New Mexico, condition of mining industry 202
copper 199–201, 203–205, 289–290
gold 199–205, 611
lead 199–201, 203–205
mineral production 114A
ores, output and metal content 199–202, 203–204
placers, output by counties 202
silver 199–205, 611
zinc 199–201, 203–204

Page.
New York, mineral production 115A
zinc 9, 11
Nickel, exports and imports 565–566
production 563
in Canada 563, 564–565
secondary, quantity recovered 190
Nonmetals, summary of production 8A–11A
North Carolina, gold and silver 8, 11–12
mineral production 115A
North Dakota, mineral production 116A

O.

Ohio, mineral production 116A
Oklahoma, lead and zinc 161–165
mineral production 117A
Oregon, copper 439, 440, 442–445
gold 439, 440–441, 442–445, 611–612
lead 439, 440, 442, 444, 445
milling 442–444
mineral production 117A
mining of copper 442
gold 441–442
platinum metals 132
silver 442, 612
mining operations 444
Baker County 445–447
Coos County 447–448
Curry County 447–448
Douglas County 448
Grant County 448–449
Jackson County 449–450
Josephine County 450–451
Malheur County 451
ores, production and content 440–441
quicksilver 119
recovery of lead 442
silver 439, 440–441, 442–445
Ores, production 68A
Osmiridium. *See* Platinum and allied metals.

P.

Palladium. *See* Platinum and allied metals.
Papua, osmiridium deposits 134
Peat, production and imports 68A–69A
Pennsylvania, copper 8, 12
gold and silver 8
mineral production 118A
Peru, antimony resources 103
Petroleum, consumption 71A
imports and exports 72A
production 69A
stocks 71A
world's production 70A
Phosphate rock, imports and exports 72A
production 72A
Pig iron, blast furnaces in blast 368
commercial quotations 364–366
imports and exports 368–369
prices 363, 364–366
production 362–363, 366–368
world's production 370
Pittman Act, effects 5A
Platinum and allied metals, consumption 128–129
crude material purchased 125
customs duties 130–131
foreign deposits 132–135
imports and exports 126–128
market and prices 129–130
occurrences 132
production 125–126, 197
secondary, quantity recovered 126
stocks 129
world's production 131
Portugal, arsenic resources 70–71
Potash, imports and exports 75A–76A
production and stocks 74A–75A
Pyrites, production and imports 76A

Q.

Quicksilver, foreign mining 119–120
imports and exports 117
market 113
ore mined and treated 115
prices 116
production 113, 114–115
publications, recent 121–124
supplies 118
world's production 114

R.

Radium, foreign production and deposits 576–579
production 575
Ransome, F. L., Quicksilver 113–124
Red light, cadmium 3–4
Refractories, aluminous 96
Rhode Island, mineral production 118A
Rhodium. *See* Platinum and allied metals.
Russia, condition of platinum mining 135
Ruthenium. *See* Platinum and allied metals.

S.

Salt, imports and exports 78A
production 77–78A
Sampson, Edward, Chromite 107–112
San Francisco district, Ariz., mining 509–510
Sand and gravel, production 78A
imports and exports 79A
Sand-lime brick, production 79A
Schrader, Frank C., Antimony 97–105
Secondary metals, classification of old metals 176–178
definition 173
market conditions 179–180
methods of recovery 174–176
prices 180–181
quantities recovered 181–190
sources 173–176
Selenium, production and imports 80A, 23–24
Siebenthal, C. E., and Stoll, A., Cadmium 1–5
and Stoll, A., Lead 27–36
Lead and zinc pigments and salts 77–85
Zinc 37–52
Silica brick, sales 80A
Silica (quartz), sales 80A
Silver, consumption in industries 596
domestic supply 599–600
imports and exports 599
mines producing 615–616
ores produced 616–619
Pittman Act, effects 5A
prefatory note to reports 125A–127A
prices, 1850–1922 14A, 127A, 596–597, 598
producers, largest 607
production, at mills 631–632
by methods of treatment 628–631
by sources 625–628
by States 49A, 595, 605
from 1792 to 1922 48A, 597
increase or decrease 596
Philippine Islands 614
sources of information 595–596, 604, 635
secondary, quantity recovered 596
world's production, 1860–1922 601–603, Pl. I
*See also* Alaska, Arizona, California, Central States, Colorado, Eastern States, Georgia, Idaho, Illinois, Michigan, Missouri, Montana, Nevada, New Mexico, Oregon, South Dakota, Tennessee, Texas, Utah, Washington, and Wyoming.
Slate, imports and exports 82A
production 81A
Smith, C. M., The manufacture of calcium arsenate 75–76
Sodium compounds, imports and exports 83A–84A
production 82A–83A
South Carolina, gold 8, 12
mineral production 119A
South Dakota, gold, silver, and lead 193–196, 612
mineral production 119A
Spain, arsenic resources 71
Spiegeleisen, consumption 592
imports 593
prices 593–594
producers 591
production 593
States, leading mineral products 14A
leading producers of each mineral product 12A–13A
Steel, condition of the industry 341–343
exports 376
imports 375
prices 373
production 373–375
Stoll, A., with Siebenthal, C. E., Cadmium 1–5
with Siebenthal, C. E., Lead 27–36
Lead and zinc pigments and salts 77–85
Zinc 37–52

Page.

Stone, imports and exports 85A
Stones, precious, imports and exports 48A
precious, production 47A
Strontium, imports and sales 86A
Sulphur, imports and exports 86A
production 86A

T.

Talc and soapstone, imports and exports 87A–88A
production 87A
Tantalum, production 88A, 567
search for uses 567
Tellurium, production and uses 88A, 25
Tennessee, bauxite mining 91
gold, silver, copper, lead, and zinc 8, 9, 12–13, 290–291, 612
mineral production 120A
Texas, mineral production 120A
quicksilver 119
silver, copper, and lead 613
Thorium minerals, imports and exports 89A
Tin, consumption 171
development work 169
imports and exports 170–171
prices 172
production 169
secondary, quantity recovered 186–188
smelting 170
Titanium, production and uses 91A, 569–570
Tungsten, analyses of ores 573
foreign production 573
former domestic production 571
imports and exports 572
production 92A
Turkey, antimony resources 104
arsenic resources 72
Type metal, imports 101

U.

Udylite process 1–2
Union of South Africa, arsenic resources 71
United Kingdom, arsenic resources 68
Uranium, imports 94A, 582
production and deposits 93A–94A, 575–579
Utah, alumina from potash plants 91
concentrates produced 384
copper 291–294, 377, 379, 381, 384–386, 388–389
expenses of labor and freight 388
gold 377, 379, 381, 384–386, 388–389, 613
history of mining 377–378
lead 377, 379, 381, 384–386, 388–389
milling of ores 384–385
mineral production 121A
mining of copper 386–387
gold 386
lead 387
silver 386
zinc 387–388
mining operations 388
Beaver County 389–390
Box Elder County 390
Juab County 390–394
Piute County 394
Salt Lake County 394–399
Sevier County 399
Summit County 399–402
Tooele County 402–403
Utah County 403
Wasatch County 399–402
Washington County 403

Page.

Utah, ores, production and content 379–383
silver 377, 379, 381, 384–386, 388–389, 613
zinc 377, 379 381, 384–386, 388–389

V.

Value of minerals produced, totals by States 98A
Vanadium, imports 94A, 583
prices 94A
production and deposits 93A, 575–581, 582
uses 581–582
world's production 94A
Vermilion range, Minn., operations 353
Vermont, mineral production 121A
Virginia, gold and silver 8, 14
mineral production 122A

W.

Warren district, Ariz., mining operations 501–503
Washington, condition of mining 249–250
counties, production 252–256
copper 245, 246, 248, 249
gold 245, 246–249, 613–614
lead 245, 246–248, 249
milling 250–251
mineral production 123A
mining operations 249–250
Ferry County 253–254
Okanogan County 254
Stevens County 255–256
Whatcom County 256
ores, production and metal content 246–248
silver 245, 246–248, 249, 613, 614
trend of mining 245–246
zinc 245, 246–247, 249
West Virginia, mineral production 123A
Wisconsin, lead and zinc 166–168
mineral production 123A
Wyoming, gold, silver, and copper 197–198, 614
mineral production 124A
mining of platinum metals 132

Y

Yugoslavia. *See* Jugoslavia.

Z.

Zinc, consumption 49
content in pigments 40
customs duties 48–49
distilled and electrolytic 38
dust 40
imports and exports 39, 45–48
plants for reduction 42–43
prices, 1875–1922 49–52
production 37
rolled 38–39
secondary, quantity recovered 40, 185–186
sulphuric acid from ores 41
world's production 44–45
*See also* Arizona, California, Central States, Colorado, Eastern States, Idaho, Montana, Nevada, New Mexico, Utah, and Washington.
Zinc pigments and salts, customs duties 81
imports and exports 78–80
prices 81–84
processes of making 77
producers 84–85
quantities marketed 78
sources of metal content 78
Zirconium ores, imports 98A
production in Brazil 97A